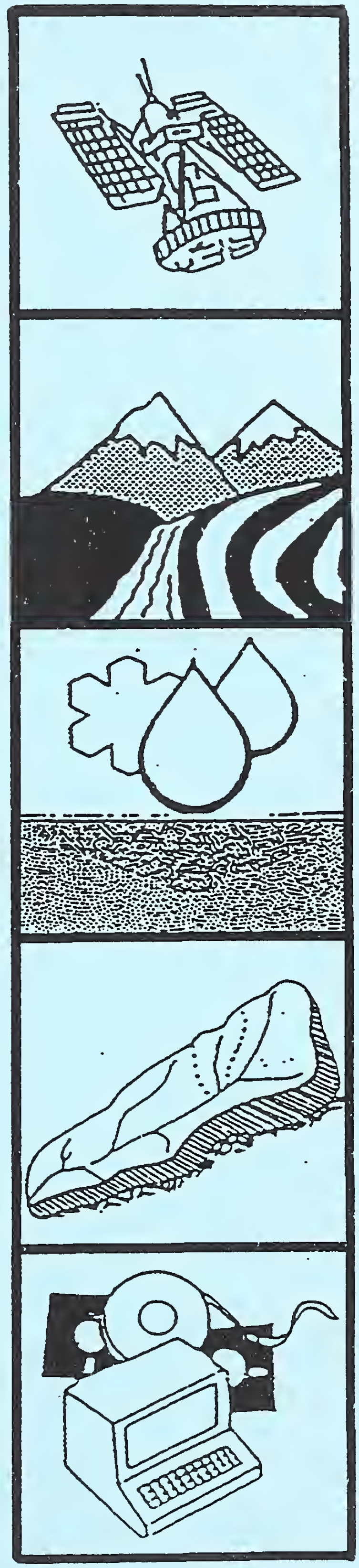
USDA - ARS
Hydrology Laboratory

Program Review



September 28 - 30, 1994

Hydrology Laboratory
Natural Resources Institute
Agricultural Research Service
U.S. Department of Agriculture
Beltsville, Maryland 20705

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AGENDA

September 28, 1994
Room 020 Building 003, BARC-W

8:15	PRE REVIEW "BREAK"	GET ACQUAINTED SESSION AND SNACKS
8:30	P. KEARNEY	INTRODUCTORY REMARKS
8:40	W. J. RAWLS	LAB OVERVIEW AND ISSUES
9:20		EXECUTIVE SESSION
10:20		BREAK
10:30		TOUR OF FACILITIES
11:15		WALTER RAWLS
12:15		LUNCH

Room 006 Building 007, BARC-W

1:15	TIM GISH
2:15	AL RANGO
3:15	BREAK
3:30	JERRY RITCHIE
4:30	REVIEW TEAM DISCUSSION

SEPTEMBER 29, 1994
Room 006 Building 007, BARC-W

8:00	TOM JACKSON
9:00	BILL KUSTAS
10:00	BREAK
10:15	KAREN HUMES
11:15	MEETING WITH SUPPORT STAFF
12:15	LUNCH
1:15	JANE THURMAN
2:15	RALPH ROBERTS
3:15	REVIEW TEAM DISCUSSION AND REPORT DRAFTING

SEPTEMBER 30, 1994
Room 006, Building 007, BARC-W

8:30	EXECUTIVE SESSION
10:30	END OF REVIEW

USDA-ARS ORGANIZATIONAL BACKGROUND

DEFINITION OF SOME TERMS, ABBREVIATIONS AND ACRONYMS USED IN ARS

ARS: Agricultural Research Service. An Agency in the Science and Education branch of USDA. ARS has about 8,000 employees, including about 2,500 senior scientists. The Agency conducts research at 127 locations in the U.S. ARS is led by an Administrator and is divided geographically into eight Areas, which are led by Area Directors.

BA: The Beltsville Area includes the Beltsville Agricultural Research Center, the Beltsville Human Nutrition Research Center, the U.S. National Arboretum, and the Glenn Dale Plant Distribution Station. The Beltsville Area, at 6,600 acres, is the Smallest Area geographically, but the largest in terms of personnel and budget. About 1,450 employees, including about 440 scientists, work in the BA.

NPS: National Program Staff. Members are called National Program Leaders and each is a subject matter specialist. NPS serves the Administrator of ARS in developing and coordinating research plans and strategies on a national basis. NPS sets National Program directions, establishes priorities, allocates resources, including this review, and acts as a clearing house for decision making. Considerable interaction between Area managers and NPS is required to fulfill our respective roles.

INSTITUTES: The Beltsville Agricultural Research Center is composed of four Institutes (see Appendix): The Plant Sciences Institute, the Livestock and Poultry Sciences Institute, the Natural Resources Institute, and the Product Quality and Development Institute.

LABORATORIES: Laboratories are units located in the Institutes. Laboratories are led, both scientifically and administratively, by Research Leaders. Typically, a Laboratory is comprised of 8-10 scientists, a scientific and clerical support staff and several temporary student and postdoctoral employees. The program and mission of a Laboratory of this size must obviously be limited. In reviewing a Laboratory, bear in mind that what appear to be discipline or program gaps are often filled by collaboration with other Laboratories in the BA or elsewhere.

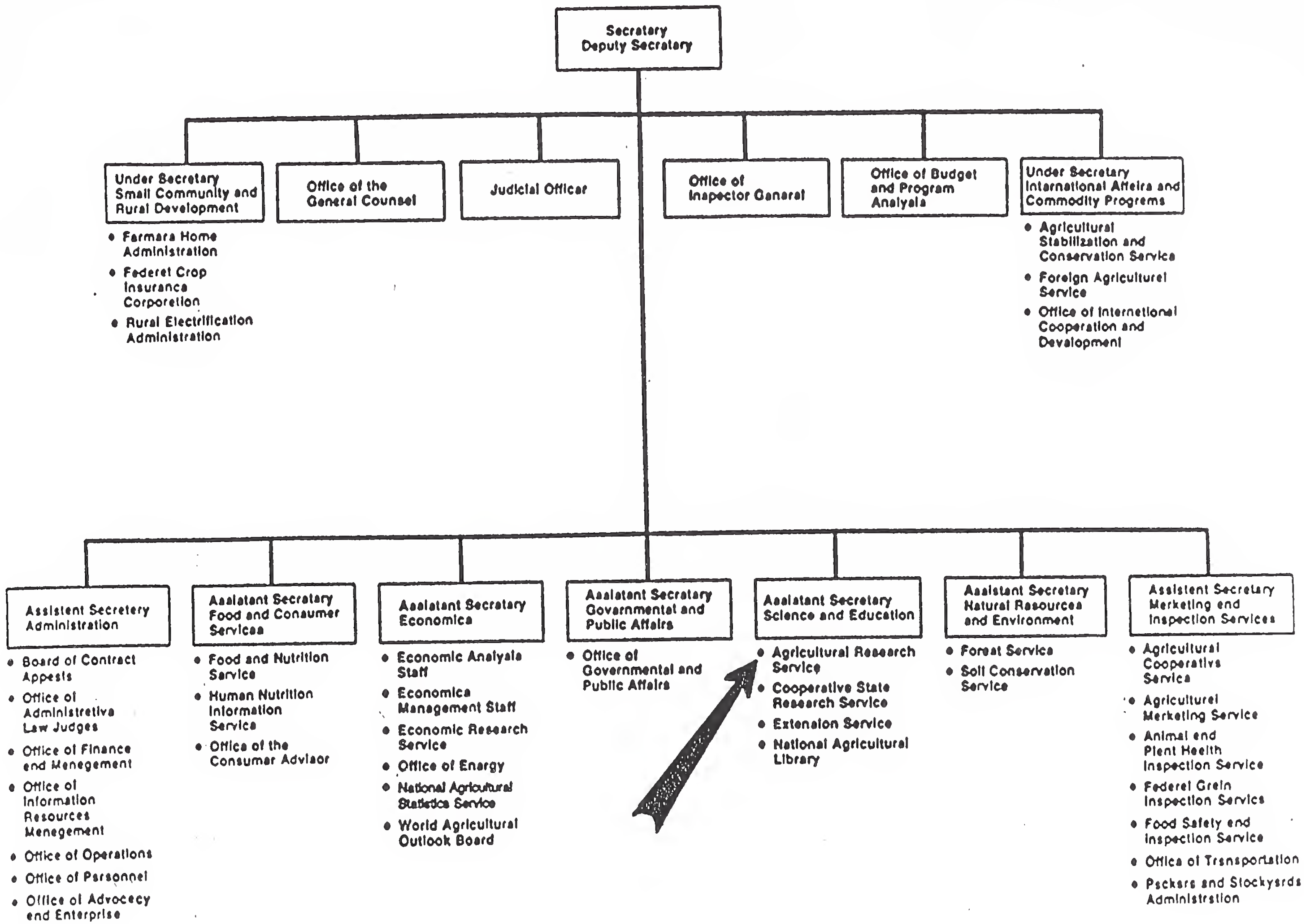
CRIS: Current Research Information System. This is an electronic system for the filing and retrieval of information about individual agricultural research projects. In ARS, the terms "CRIS Work Unit" or the acronym "CRIS" are used synonymously with "research project" or "project." New projects are planned in coordination with NPS and are subjected to peer-review. The normal life of a project in ARS is 3 to 5 years.

SY: Scientist Year. This is the effort of a research scientist for 1 year. Fractional efforts (e.g., 0.5 SY) in a given project are possible when a scientist works in more than one project during the course of a fiscal year. The term is also used in ARS as a synonym for a research scientist [e.g., "I have six SYs (research scientists) in my Laboratory"].

OTHER KINDS OF SCIENTIFIC PERSONNEL: Research scientists are responsible for all phases of research. ARS also employs research associates ("postdocs"), support scientists (who have responsibility for some portion of a project), technicians, students, and in some operations, nonresearch scientific personnel who perform work involving service to the public or to other government agencies.

AM: Administrative Management. This branch of ARS manages support activities, such as procurement, facilities, fiscal allocations and personnel operations at all levels in ARS.

USDA Organizational Chart



ARS
Administrator
&
Associate Administrator

Deputy Administrator
National Program
Staff

Deputy Administrator
Administrative
Management

Pacific West Area*

Northern Plains Area*

Southern Plains Area*

Beltsville Area*

Midwest Area*

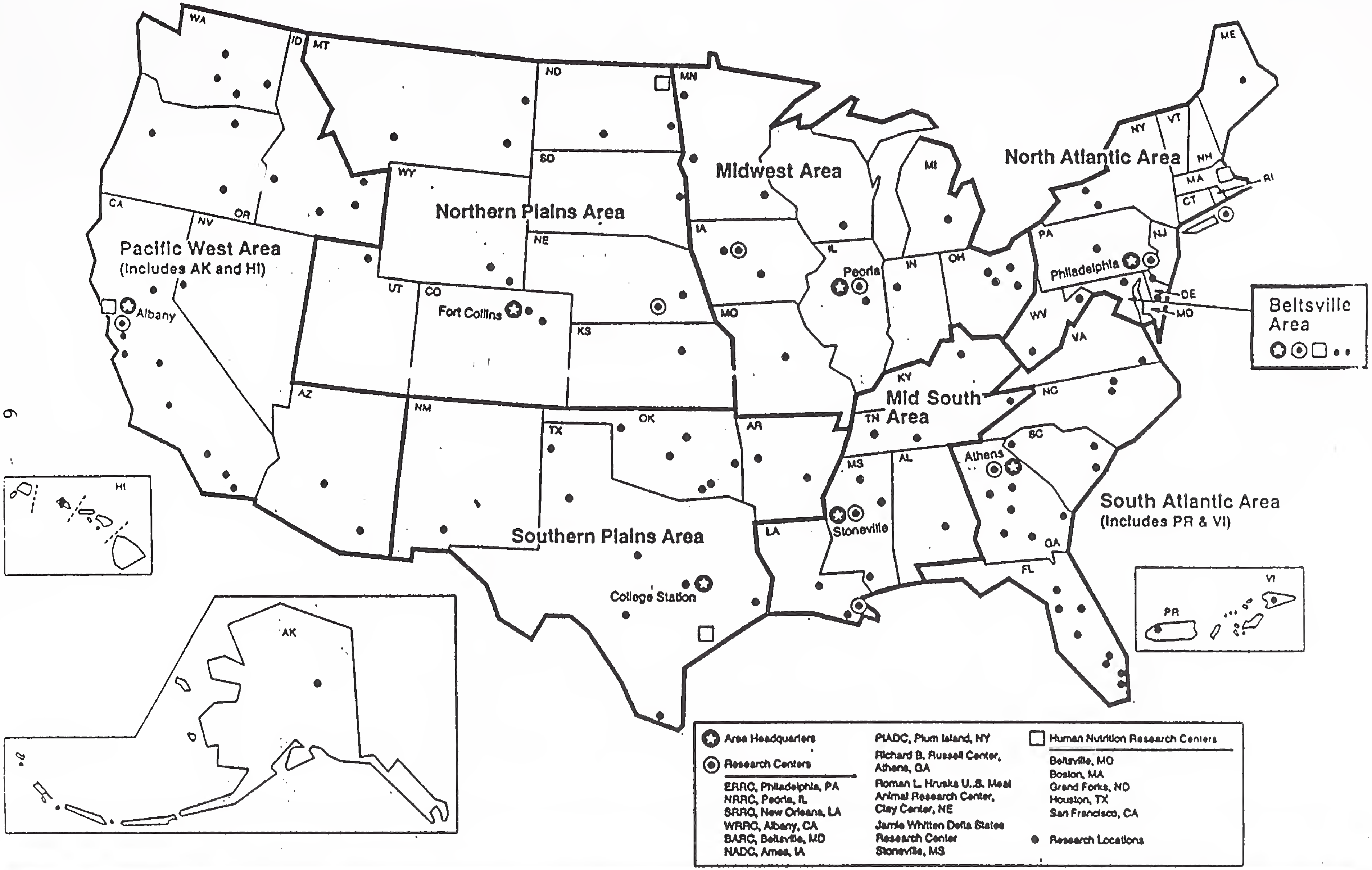
North Atlantic Area*

South Atlantic Area*

Mid South Area*

[*Each Area is led by an Area Director and an Associate Area Director]

Agricultural Research Service – Area Organization



June 1987

USDA, AGRICULTURAL RESEARCH SERVICE
BELTSVILLE AREA

AREA DIRECTOR
K. D. MURRELL

ASSOCIATE AREA DIRECTOR
G. C. MARTEN

U.S. NATIONAL ARBORETUM
- DIRECTOR — T. E. Elias
- ADMINISTRATIVE & FACILITIES MGR. — C. Homberger
- EDUCATION UNIT — E. A. Neumann
- GARDENS UNIT — S. G. March
- GERMPLASM UNIT — E. J. Garvey
- FLORAL & NURSERY PLANTS RES. UNIT — R. H. Lawson

BELTSVILLE HUMAN NUTRITION RESEARCH CENTER
- DIRECTOR — J. Spence
- CARBOHYDRATE NUTRITION — J. G. Hallfrisch
- ENERGY & PROTEIN NUTRITION — P. W. Moe
- LIPID NUTRITION — J. T. Judd
- NUTRIENT COMPOSITION — G. R. Beecher
- VITAMIN & MINERAL NUTRITION — J. C. Smith

NATURAL RESOURCES INSTITUTE
- DIRECTOR — P. C. Kearney
- CLIMATE STRESS — S. Britz
- ELECTRON MICROSCOPE — W. P. Wergin
- ENVIRONMENTAL CHEMISTRY — R. J. Wright
- HYDROLOGY — W. J. Rawls (Acting)
- REMOTE SENSING RESEARCH — G. F. Hart
- SOIL MICROBIAL SYSTEMS — P. D. Millner
- SYSTEMS RESEARCH — J. C. Ritchie (Acting)

PLANT SCIENCES INSTITUTE
- DIRECTOR — J. B. St. John
- ASSOCIATE DIRECTOR — J. J. Menn
- BEE RESEARCH — H. Shimanuki
- BIOCONTROL OF PLANT DISEASES — R. D. Lumsden
- FRUIT — R. F. Korcak
- INSECT BIOCONTROL — J. L. Vaughn
- INSECT CHEMICAL ECOLOGY — B. Leonhardt
- INSECT NEUROBIOLOGY & HORMONE — J. A. Svoboda
- MOLECULAR PLANT PATHOLOGY — R. E. Davis
- NATIONAL GERMPLASM RESOURCES — A. K. Stoner
- NEMATOLOGY — D. J. Chitwood
- PLANT MOLECULAR BIOLOGY — A. K. Mattoo
- SOYBEAN AND ALFALFA RESEARCH — D. L. Keister
- SYSTEMATIC BOTANY & MYCOLOGY — A. Y. Rossman
- SYSTEMATIC ENTOMOLOGY — M. B. Stoetzel (Acting)
- VEGETABLE — S. L. Sinden
- WEED SCIENCE — J. D. Anderson

LIVESTOCK AND POULTRY SCIENCES INSTITUTE
- DIRECTOR — T. J. Sexton
- ANIMAL IMPROVEMENT PROGRAMS — H. D. Norman
- BIOSYSTEMATIC PARASITOLOGY — J. R. Lichtenfels
- GENE EVALUATION AND MAPPING — C. E. Rexroad
- GERMPLASM & GAMETE PHYSIOLOGY — L. A. Johnson
- HELMINTHIC DISEASES — J. F. Urban
- LIVESTOCK INSECTS — D. K. Hayes
- MILK SECRETION & MASTITIS — R. H. Miller
- NONRUMINANT ANIMAL NUTRITION — M. C. Steele
- PROTOZOAN DISEASES — M. D. Ruff
- RESEARCH ANIMAL SERVICES — K. Hummel
- RUMINANT NUTRITION — T. S. Rumsey
- VETERINARY SERVICES — B. Stroud
- ZOONOTIC DISEASES — R. Fayer

FACILITIES MANAGEMENT AND OPERATIONS DIVISION
- DIRECTOR — W. G. Horner
- ADMINISTRATIVE BRANCH — C. Bowie (Acting)
- FACILITY ENGINEERING BRANCH — R. D. Little
- FARM OPERATIONS BRANCH — H. T. Badger

PRODUCT QUALITY AND DEVELOPMENT INSTITUTE
- DIRECTOR — D. D. Bills
- FAMILY ECONOMICS RESEARCH GROUP — F. Schwenk
- HORTICULTURAL CROPS QUALITY — A. E. Watada
- INSTRUMENTATION AND SENSING — Y. R. Chen
- MEAT SCIENCE RESEARCH — M. B. Solomon
- PESTICIDE RESEARCH STAFF — D. D. Bills

REVIEW TEAM

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Ithaca, NY 14853

USDA HYDROLOGY LABORATORY

BACKGROUND

The Hydrology Laboratory was established in 1961 and was originally known as the Hydrograph Laboratory. In 1978 the name was officially changed to the Hydrology Laboratory. In the 1984 reorganization, the Water Data Laboratory was merged with the Hydrology Laboratory as a subset known as the Water Data Center.

PROBLEM

The demand for increased agricultural production in conjunction with ever-increasing environmental constraints requires improved management and utilization of our land and water resources on a national scale. Recent concern about the effects of global climate change requires a better understanding of the large scale water cycle and its consequences for regional water supplies. While agriculture is by far the largest user of water, much of the water that other users depend upon also comes from agricultural lands. Consequently, an improved knowledge of how agricultural practices affect the quality of both surface and groundwater is needed as additionally competition for water increases in areas of short supply, there will be increased pressures on agriculture to share its water. In order to minimize the impact of the competition for water on agriculture, we must learn how to increase water-use efficiency, to improve our water yield forecasts for agricultural lands, to better predict the effects of land management on water resources, and to establish linkages between large scale processes and watershed or agricultural field-scale hydrology.

MISSION

To meet future needs, the research mission of the Hydrology Laboratory includes the development of improved methodologies for predicting water yield from and for agricultural lands and for monitoring and evaluating the impact of management practices and large scale environmental changes on water resources. In the developmental process, new emerging technologies will be tested for future applicability to water resources modeling, prediction, and management. Areas of emphasis include remote sensing, hydrological modeling, water quality, and climate change effects. Additionally, the Water Data Center provides advanced data processing, storage, management and retrieval techniques and services to relevant ARS hydrologic locations, and develops data sets for cooperative hydrologic modeling efforts. The research program at the Hydrology Laboratory is nationally oriented and addresses both basic and applied research.

RESEARCH ACCOMPLISHMENTS

Macropore Characterization

Preferential movement of surface applied chemicals to the groundwater has resulted in a great need to physically model the movement of water into and through the soil. Knowledge of the matrix and macropore saturated hydraulic conductivity is critical to describing these field scale processes. Utilizing fractal principles, methods were developed to describe macropores and modified the Marshall saturated hydraulic conductivity equation to predict the hydraulic conductivity based on soil properties. This new development enables the domain concept for modeling both macropore and matrix flow in soils to be used, thus, allowing the identification of potential pollutant paths and the assessment of agricultural practices on these paths.

Herbicide Environmental Fate

Herbicide controlled release formulations were evaluated in humid coastal plain soils, and although not optimized have demonstrated a reduction in environmental loss relative to commercial formulations. The controlled release formulations have a rate-of-release which is governed by a diffusion process, allowing only a fraction of the pesticide to interact with the environment at a given time. As a result, preferential herbicide transport can be eliminated and surface runoff reduced. Additionally, starch-encapsulation can reduce herbicide volatilization, especially on no-tillage, with equal or better weed control.

Climate Change Effects on Water Supply

It is extremely difficult to project the potential effects of climate change on water supply. The best tool available for this is a hydrologic model. Because the majority of water in the West comes from snowmelt, the Snowmelt Runoff Model (SRM) has been employed for such projections. In addition to changes in temperature and precipitation which can be input directly, it has been necessary to develop an algorithm that calculates changes in basin snow cover under the new climate. It has been discovered that many model parameters, which have been overlooked by other investigators, will also change in a response to the changing climate. Use of SRM under conditions of climate change has shown that the spring runoff peak will shift by 3-4 weeks earlier in the year and that summer runoff will decrease markedly while winter runoff will increase. Water resources management for irrigation, hydropower, and domestic supplies will have to change to keep pace with the changes in climate.

Vegetation Correction Algorithm for Microwave Remote Sensing of Soil Moisture

Passive microwave data have been used to establish an algorithm for estimating surface soil moisture. A theoretical model of the effect of vegetative cover on the emission of soils was developed and adapted for a wide range of conditions. Results showed that the effects were not significant when a readily obtained vegetation parameter was included and the appropriate sensor wavelength was used. Further studies including field experiments and the adaptation of previous research results have broadened the applicability of the model and provided a better understanding of the dominant physical parameters.

New Antenna Technology Evaluated for Soil Moisture Applications

A multibeam aircraft passive microwave radiometer utilizing new synthetic aperture technology was built and installed on a NASA aircraft. This was accomplished through the cooperative efforts of NASA, ARS, and the University of Massachusetts. The performance of the prototype instrument was successfully verified in two large scale experiments. In the first study conducted in Walnut Gulch, AZ, a short duration experiment showed that soil moisture estimates had accuracies comparable with ground sampling and other aircraft sensors. A longer duration experiment was conducted the following year in the Little Washita watershed, OK. This study involved mapping over 600 km^2 at a 200 m resolution every day for an eight day period. The resulting data revealed significant spatial patterns in soil moisture that have been associated with the soil texture distribution of the region. These data sets are being distributed to co-investigators for integration into large scale water and energy balance modeling of the region.

Measuring Landscape Properties Using An Airborne Laser Altimeter

Measurements of vertical landscape surface properties have been made using a laser altimeter mounted in an airplane and analyzed to provide data on topography, surface roughness, stream and gully cross-sections and vegetation canopy properties (heights, cover, structure, and distribution). Laser measurements of vegetation cover and height were significantly correlated to ground measurements made with line intercept methods. Airborne laser data of topography and canopy height were used to estimate aerodynamic roughness lengths for landscape elements which correlated well with measurements made using standard meteorological data. Measurements of macroscale and microscale topography can contribute to a better quantification of the movement of water over landscape surfaces and in channels and across flood plains. Measurements of canopy properties and their distribution across the landscape and their effects on water movement and aerodynamic roughness allow better quantification

and understanding of evaporative loss as well as infiltration and surface water movement. Airborne laser altimeters offer the potential to measure large areas quickly and easily. Such measurements provide valuable data for understanding and managing natural resources at large scales.

Satellite Measurements of Water Quality

Concentrations of chlorophyll-a in waters with high average annual concentrations of suspended sediment were measured in three lakes and compared with broad band Landsat MSS satellite digital data for 104 dates between December 1976 and August 1988. Concentrations of chlorophyll-a ranged from 0.3 to 211 $mg \cdot m^{-3}$ for 452 measurements. Concentrations of suspended sediment ranged from 1 to 867 $mg \cdot l^{-1}$ in the same samples. In general, chlorophyll-a concentrations were inversely related to suspended sediment concentrations. Radiance and reflectance calculated from the four MSS bands increased as a function of increasing concentrations of suspended sediment. Radiance and reflectance were inversely related to the concentration of chlorophyll-a, but the relationships were not statistically significant. This study indicated that the measurement of chlorophyll-a with broad band (100 nanometer) MSS data in waters dominated by suspended sediments is not effective since the detection of the increased absorption or reflectance of radiation due to chlorophyll-a is masked by the spectral reflectance due to suspended sediments. In order to quantitatively determine chlorophyll by remote sensing in systems dominated by suspended sediment high spectral resolution information (10 to 15 nm band widths) at approximately 675 and 705 nanometers (nm) will be required.

Estimation of Surface Soil Moisture

As part of the Monsoon 90 and HAPEX-Sahel experiments, we flew the PushBroom Microwave Radiometer (PBMR) to study the capability of this sensor to monitor surface soil moisture changes and to use these data in the estimation of surface fluxes. By flying a series of parallel flight lines it was possible to map microwave brightness, and thus the soil moisture, over a large area. The data were processed in the Hydrology Lab to produce maps of microwave brightness temperatures. In the Monsoon 90 case, the area was approximately 8 by 20 km. The moisture conditions ranged from very dry, <2%, to quite wet, >15%, (after a heavy rain). The rain amounts ranged from less than 10 mm to more than 50 mm over the area mapped with the PBMR. With the PBMR we were able to observe the spatial patterns of the rain amounts and the temporal variation of the moisture content as the soil dried. The brightness temperatures were compared to the rain gage readings and to the ground measurements of soil moisture in the 0 to 5 cm layer. The decreases in brightness temperature were well correlated with the rainfall amounts, $r^2 = 0.8$, up to rain amounts of 25 mm, after which the effect saturated. The

comparison of the brightness temperatures with soil moisture was also good with an r^2 of about 0.8. For the latter, there was some dependence of the relation on location which may be due to soil or vegetation variations which is currently under study along with the use of these data for surface flux estimation. For HAPEX-Sahel, the area mapped was similar (8 x 30 km) as was the range of surface soil moisture conditions. In this experiment, we were able to relate the differences in surface drying to heterogeneities in the soil hydraulic properties.

Spatially Distributed Basin Fluxes

The capability to compute spatially distributed energy and water fluxes over a basin is essential for identifying sources and sinks of hydrologic, atmospheric and biogeochemical fluxes. Remote sensing information provides key spatial information which has been utilized in operational models for extrapolating local fluxes to whole basins. This technique has been tested at field and basin scales over agricultural and natural landscapes. For area-averaged regional scale fluxes, similarity formulations for the atmospheric boundary layer have been combined with surface temperature and reflectance data collected over large areas. The models developed are the first of their kind for computing all components of the energy balance in a spatially distributed manner using primarily remote sensing data. The results have important implications on the role of remote sensing technology in climate and hydrologic research. The model-derived fluxes will provide one of the few independent methods for evaluating new techniques and concepts used in prognostic hydrologic and climate models for computing spatially distributed fluxes at regional scales.

Estimating Surface Temperature Remotely

Surface temperature is a key remotely sensed variable for estimating the partitioning of available surface energy into heat and moisture fluxes from the surface to the atmosphere. However, the emissivity of the surface must be known in order to convert radiometric temperature measured with remotely sensed data to a physically meaningful temperature. Appropriate values of that parameter for semi-arid ecosystems are not well known. Ground-based remotely sensed data were used to estimate surface emissivity for two very typical semi-arid ecosystems (desert grasslands and shrubland).

Data Management System

Software has been developed for managing, accessing, and displaying water data stored in the ARS Water Data Base CD-ROM. The program is designed to operate in a Microsoft Windows environment. It allows the user to navigate through the data base, supports several different types of query selection, and

links together water data, land use data, maps, and other supporting text files, where available. A graphical component allows a user to view a series of map images that represents a selected ARS location, in sequences chosen by the user. A location's map image set may include watershed and subwatershed boundaries, raingage and weir locations, topographic maps, soils maps, etc. Data base files on the CD can be viewed graphically, as hyeto/hydrographs, or in textual form, using a browse window. Selected data years can be output in printed form, or copied to external files or the Windows clipboard, for use by other programs. The initial version of this software is currently undergoing testing and modification, using the basic (precipitation and runoff data only) ARS Water Data Base on CD-ROM.

ARS Water Data Base

The ARS Water Data Base has been expanded to over 16,000 station years of hydrologic data. These data are useful to researchers, hydrologists, and engineers for climate change studies, hydrologic modeling, and comparing management strategies. The data are made available through various methodologies including on-line phone access, Internet, and CD-ROM with the goal of maximum support for the research community.

HYDROLOGY LABORATORY SCIENTIFIC PERSONNEL AND EXPERTISE

Dr. Tim Gish	**Soil Scientist:**	fluid dynamics, mathematics, spatial variability, preferential flow and transport, groundwater quality
Dr. Karen Humes	**Hydrologist:**	remote sensing, evapotranspiration, surface energy balance, soil moisture modeling
Dr. Tom Jackson	**Hydrologist:**	remote sensing, soil moisture and soil water modeling, hydrologic modeling
Dr. Bill Kustas	**Hydrologist:**	remote sensing, energy balance modeling, regional evapotranspiration, atmospheric boundary layer theory
Dr. Al Rango	**Hydrologist:**	remote sensing, snowmelt, runoff modeling, watershed management, climate change
Dr. Walter Rawls	**Hydrologist & Research Leader**	infiltration, hydrologic soil properties, watershed modeling
Dr. Jerry Ritchie	**Soil Scientist:**	remote sensing, erosion, sedimentation, water quality monitoring, geographic information system
Mr. Ralph Roberts	**Computer Program Analyst:**	microcomputer hydrologic modeling, computer graphics, systems analysis
Dr. Tom Schmugge	**Physical Scientist:**	remote sensing, surface temperature, soil moisture, evapotranspiration
Ms. Jane Thurman	**Computer Systems Analyst:**	data base management, personal computers, graphics, interactive programming

SUPPORT STAFF

Charles Dickson	Computer Assistant
Jeanette Kim	Computer Assistant
Julie Lephew	Secretary, Office Automation
Lynn McKee	Soil Scientist
Alice Murray*	Office Automation Assistant
Laura O'Hare*	Office Automation Assistant
Robert Parry	Hydrologic Technician
Ralph Roberts	Computer Program Analyst
Jane Thurman	Computer Program Analyst

* half time

VISITING SCIENTIST

1992 - 1994

Dr. Larry Hipps	Utah State University
Dr. Don Brakensiek	University of Maryland
Mr. Karl Hollenbeck	University of Virginia
Dr. K.-J. Samuel Kung	University of Wisconsin
Dr. Sheldon Nelson	Brigham Young University
Dr. Ghami Chehbouni	NASA
Dr. Suatopluk Matula	Czechoslovakia
Ms. Patricia Bougarel	France
Dr. Laurent Prevot	France
Dr. Andre Chanzy	France
Dr. Arie Markus	Israel
Mr. M. K. Goel	India
Mr. Peter van Oevellen	Netherlands
Dr. Massino Menenti	Netherlands
Dr. Anatolij Shutko	Russia
Dr. Milica Mojasevic	Serbia
Dr. Cesar Coll	Spain
Dr. Jaroslav Martinec	Switzerland
Dr. Michael Baumgartner	Switzerland

COOPERATIVE RESEARCH AGREEMENTS

University of Maryland

Howard University

University of Delaware

University of Massachusetts

Utah State University

Manaaki Whenua Landcare Research, New Zealand

Houston Advanced Research Center

University of Arizona

Brigham Young University

Pennsylvania State University

University of Virginia

HYDROLOGY LABORATORY

1992 - 1994 PRODUCTIVITY SUMMARY

SCIENTIST	PEER REVIEWED PUB. 1ST AUTHOR	PEER REVIEWED PUB. CO-AUTHOR	OTHER PUBLICATIONS	ABSTRACT/SCI. PRESENTATIONS
GISH	3	5	6	7
HUMES	2	2	9	8
JACKSON	5	12	14	20
KUSTAS	6	17	4	16
RANGO	6	8	12	20
RAWLS	2	2	13	13
RITCHIE	5	4	14	30
SCHMUGGE	3	10	23	6
TOTAL	32	60	95	120

PEER REVIEWED PAPERS: 92
TOTAL PUBLICATIONS: 187

PUBLICATIONS PER SY PER YEAR

	Peer Reviewed	All Publications
1986 - 1988	3.2	6.0
1989 - 1991	3.8	6.4
1992 - 1994	4.2	8.8

SUMMARY
HYDROLOGY LABORATORY
OLD CRIS PROJECTS

CWU NO.	TITLE	NET TO CRIS	PROPOSED ACTION
1270-13000-004-00D	Quantification & Integration of Basin Scale Hydrologic Fluxes (W. Kustas)	$509,314	Rewrite 9/94
1270-13000-005-00D	Processes Related to Water Quantity and Quality (W. Rawls)	$323,946	Rewrite 9/94
1270-13660-003-00D	Remote Sensing for Hydrology (T. Jackson)	$560,502	Rewrite 9/94
1270-13660-004-00D	Storage & Distribution of ARS Water Data (J. Thurman)	$296,183	Terminate and incorporate with 1270-13000-004-00D 1270-13000-005-00D 1270-13660-003-00D
0500-00032-033-00D	Minimizing Preferential Transport of Pesticides & Nitrogen to Groundwater (T. Gish)	$125,000	Terminate 9/96
	TOTAL:	*$1,814,943*	

SUMMARY
HYDROLOGY LABORATORY CRIS PROJECTS

CWU NO.	TITLE	NET TO CRIS	PROPOSED DURATION
1270-13000-006-00D	Environmental Hydrology (W. Rawls)	$420,000	10/94 - 10/99
1270-13610-004-00D	Hydrologic & Climate Processes at Basin Scale (W. Kustas)	$660,000 ($40,000 Temporary)	10/94 - 10/99
1270-13660-005-00D	Remote Sensing for Hydrology (T. Jackson)	$718,311 ($40,000 Temporary)	10/94 - 10/99
0500-00032-033-00D	Minimizing Preferential Transport of Pesticides & Nitrogen to Groundwater (T. Gish)	$125,000	10/93 - 10/95

Total $1,923,311

DISTRIBUTION OF SCIENTIFIC PERSONNEL AMONG CRIS PROJECTS

SCIENTIST	Environmental Hydrology 1270-13000-006-00D	Hydrologic and Climate Processes at Basin Scale 1270-13610-004-00D	Remote Sensing for Hydrology 1270-03660-005-00D	Minimizing Preferential Transport of Pesticides and Nitrogen to Groundwater 0500-00032-033-00D
T. Gish	0.6	0.2		0.2
K. Humes		0.5	0.5	
T. Jackson		0.3	0.7	
W. Kustas		0.7	0.3	
A. Rango	0.4	0.3	0.3	
W. Rawls	0.6		0.2	0.2
J. Ritchie	0.2	0.4	0.4	
T. Schmugge		0.5	0.5	
Total Scientific Years	1.8	2.9	2.9	0.4
Annual Funding	$420,000	$660,000	$718,311	$125,000

Summary of Hydrology Laboratory Financial Resources

	FY '93	FY '94	FY '95
Net to Location	1,735,543	1,814,943	1,923,311
Indirect Research Cost	196,028	186,556	214,642
Adjustments			
Post Doc	44,000		
Water Quality	125,000	125,000	125,000
Climate Change			80,000
Net to MU	1,539,515	1,628,387	1,708,669
Salary	1,077,007	1,092,224	1,134,445
All-Other	462,508	536,163	574,224
Salary: All Other	2.32	2.04	1.98
Bench dollars per SY	247,649	226,868	240,414
Discretionary dollars per SY	40,501	40,020	44,278
Percent discretionary	16.4	17.6	18.4
Percent fixed funds	83.6	82.4	81.6

Employee Name	Position Number	Position Title	Pay Plan & Grade(FPL)	Status	FTE	Salary	Footnote	ECD Date/ RA Exp Date
RAWLS, WALTER	1B3481	SUPERVISORY HYDROLOGIST	GM-15(0)	PFT	1.00	94,508	L2 M1 L1	
RANGO, ALBERT	1B3478	HYDROLOGIST	GM-15(0)	PFT	1.00	104,866		
RITCHIE, JERRY	1B3479	SOIL SCIENTIST	GM-15(0)	PFT	1.00	104,659		
PARRY, ROBERT	7B3488	HYDROLOGIC TECHNICIAN	GS- 8(8)	PFT	1.00	36,978		
SCHMUGGE, THOMAS	1B3480	RESEARCH PHYSICAL SCIENTIST	GS-15(15)	PFT	1.00	99,698		
JACKSON, THOMAS	1B3482	HYDROLOGIST	GS-15(15)	PFT	1.00	97,137	L1	
KUSTAS, WILLIAM	1B3477	HYDROLOGIST	GS-14(14)	PFT	1.00	81,210	L1	
GISH, TIMOTHY	1B3484	SOIL SCIENTIST	GS-14(14)	PFT	1.00	78,728		
MCKEE, LYNN	3B3485	SOIL SCIENTIST	GS-11(11)	PFT	1.00	51,463		
THURMAN, JANE	6B4188	COMPUTER SPECIALIST	GM-13(0)	PFT	1.00	70,648		
KIM, JEANETTE	9B3776	COMPUTER ASSISTANT (DTRNS)	GS- 7(7)	PFT	1.00	41,630		
ROBERTS, RALPH	6B4189	COMPUTER SPECIALIST	GS-13(13)	PFT	1.00	72,938		
HUMES, KAREN	1B4947	HYDROLOGIST	GS-12(12)	PFT	1.00	70,149		
DICKSON, CHARLES	9B3501	COMPUTER ASSISTANT	GS- 7(7)	PFT	1.00	48,874		
LEPHEW, JULIE	9B3489	SECRETARY (OA)	GS- 6(6)	PFT	1.00	33,309		
MURRAY, ALICE	9B3492	OFFICE AUTOMATION ASST.	GS- 5(5)	PPT	0.50	16,325	S1	
O'HARE, LAURA	9B3502	OFFICE AUTOMATION ASST.	GS- 5(5)	PPT	0.50	16,325	S1	
					16.00	1,119,445		

Non Federal FTE

Type	FTE
Research Support Agreement	2.50
Support Service Contract	0.00
Donated	0.00
Revolving Funds	0.00
Other	0.00
	2.50

Footnotes:

L1 -Level I SY (i.e., Lead Scientist/Project Leader).
L2 -Level II SY (i.e., Research Leader).
M1 -Exigency employee must report to or remain on work site regardless of extreme weather or other emergency conditions.
S1 -Position/Employee received technical supervision from incumbent of position number 9B3489.

HIGH PRIORITY RESEARCH NEEDS

Large scale Experiments: A common theme in much of our research is the extension of theory and small scale research to large areas and applications. In the past we have relied upon the support of NASA and their aircraft program to fly the sensors and missions that are critical to this research. Under their previous arrangements, our cooperators were able to obtain the flight hours to support us. Current NASA headquarters policy has eliminated this support leaving us in a position of funding such missions ourselves. These missions typically cost on the order of $100K. Current budgets cannot absorb these costs. We would like to have an increase in funding that is directed specifically to support the aircraft based experiments.

Scanning Laser System: Research using a single beam airborne profiling laser has shown the need for a multibeam scanning airborne laser system to expand areal coverage of laser measurements used to measure landscape topography, stream and gully cross sections and surface roughness. It would be a prototype instrument for eventual use by agencies like SCS, Forest Service, and Geological Survey. Estimated cost $350,000.

MANAGERIAL PROBLEMS AND OPPORTUNITIES

Hydrology Laboratory, NRI September 28, 1994

Opportunity: Research over the next five years will begin to utilize operational and research satellites much more than in the past as new sensors are launched. Within the next ten years over seventy five percent of the lab's research will rely on remote sensing based sensors. To take advantage of the research opportunities these sensors will offer, we must be prepared to handle and process large amounts of data that may be supplied from archives or in real time. In addition, each satellite and sensor will present a unique set of problems that will have to be solved. To remain on the frontier of remote sensing research for hydrology, the lab must continue to enhance its computer hardware and software. Also, there is a need to add skilled technical personnel to maintain these systems and perform what we envision to be a large volume of data processing, storage and retrieval.

Suggested solution: Reassign some of the Water Data Center computer support personnel to this activity and pursue support for a new position in this area.

SAFETY AND HEALTH REPORT

All items identified by the Safety and Health Office have been corrected. The lab safety program is ongoing with each problem identified and corrective action taken by the Lab safety officer with cooperation from every lab member.

RESPONSE TO PREVIOUS REVIEW

No items were identified in the previous review.

I. Timothy J. Gish, Soil Scientist

II. CRIS Projects:

Old CRIS Project 1270-13000-005-00D: Hydrologic Processes Related to Water Quantity and Quality
New CRIS Project 1270-13000-006-00D: Environmental Hydrology

Objective: Determine the effects of agricultural management systems on infiltration and chemical transport; specifically, to develop transport parameters which are sensitive to management and to evaluate the effect of various management systems on groundwater loading and chemical leaching.

Progress: Pesticide field behavior was found to be strongly influenced by climate variables (precipitation timing relative to application), management strategies (tillage practice, chemical formulation, and mode of application) as well as hydrogeology (soil texture, depth to ground water, etc.). These studies have shown that models which focus on pesticide chemistry alone are poor indicators of environmental impact and that climate and management strategies must to be incorporated if environmental impacts are to be simulated.

Plans: Improved methods for quantifying chemical transport must be developed. Flux-averaged concentrations from solution lysimeters may be a viable alternative to solution-concentration based values. Additionally, the non-equilibrium nature of pesticide preferential transport will be simultaneously determined and comparisons of solution and soil core pesticide concentrations evaluated f(x, t, tillage practice, formulation, etc.). Last, new concepts must be developed which compare and evaluate field data with its inherent spatial and temporal variability.

Old CRIS Project 1270-13610-002-00D: Quantification and Integration of Basin-scale Hydrologic fluxes
New CRIS Project 1270-13610-004-00D: Hydrologic and Climate Processes at Basin Scale

Objective: To evaluate pesticide volatilization as a function of managerial practice and chemical formulation.

Progress: Herbicide volatilization is strongly influence by chemical formulation, soil water content, temperature, surface residue conditions, and chemical characteristics. As much as 20% of the applied alachlor and 8% of the applied atrazine can be lost through volatilization. These studies indicate that once the herbicide gets below plant residue (no-tillage), cumulative

herbicide volatilization losses can be reduced by 50% relative to tilled (no plant residue) conditions. As a consequence, utilization of no-tillage practices in the humid east may have additional positive impacts on water quality by reducing volatilization losses.

Plans: Basic volatilization research on precipitation timing, surface residue amount (air exchange), and formulations will be conducted in large glass ecosystem chambers. Development of simple, cost effective instrumentation of pesticide vapor flux measurements will continue. Additionally, comparison of pesticide vapor fluxes will be conducted using atmospheric and chamber methodologies.

CRIS Project 0500-00032-033-00D Minimizing Preferential Transport of Pesticides and Nitrogen to Groundwater

Objective: To develop managerial practices and chemical alternatives which will minimize preferential transport of nitrogen and pesticides to groundwater.

Progress: These studies have shown that preferential transport is a major flow mechanism responsible for pesticide contamination of groundwater. By using chemical alternatives that place more emphasis on diffusion, preferential pesticide transport can be dramatically reduced. In addition, this studies have shown that no-tillage practices can have a positive impact on both surface runoff and atrazine leachate levels exiting the root zone ($\approx$1.8 m).

Plans: The reduction in atrazine parent compound and larger metabolite concentrations under no-tillage fields suggest enhanced biological degradation in preferential flow pathways relative to tilled fields. Impact of degradation in established preferential flow channels (old root channels) will be evaluated. We will also evaluate chemical characteristics and granules size on rates-of-release from starch granules and impact on minimizing convective pesticide transport in calcareous soils.

III. Cooperators:

ARS Beltsville:

Ali Sadeghi and Alan Isensee, Environmental Chemistry Laboratory, USDA-ARS, Beltsville, MD
Charles S. Helling and C. B. Coffman, Weed Science Laboratory, USDA-ARS, Beltsville, MD

Other:

K. J. Samuel Kung, Dept. Soil Science, Univ. of Wisconsin,

Madison, WI
Milica Mojašević, Chemist, Univ. of Belgrade, Belgrade, Serbia
Arie Markus, Institute of Chemistry and Chemical Technology, Beer-Sheva, Israel
Tammo Steenhuis, Dept. of Agricultural Engineering, Cornell Univ., Ithaca, NY
Sheldon Nelson, Dept. of Agronomy and Horticulture, Brigham Young University, Provo, UT
Michael Hickman and Marvin Schreiber, Insect and Weed Control Research USDA-ARS, Purdue University, West Lafayette, IN
Adel Shirmohammadi and William Magette, Dept. of Agricultural Engineering, Univ. of Maryland, College Park, MD

IV. Curriculum Vitae:

Education:

1975	B. S., Soil Science, Brigham Young University
1981	Ph.D., Soil Physics, University of California, Riverside

Professional Employment:

1976-1981	Graduate Research Assistant, Dept. Soil and Environmental Sciences, Univ. Calif., Riverside, Riverside, CA
1981	Post Doctoral Research, Dept. Soil and Environmental Chemistry, Univ. Calif., Riverside, Riverside, CA
1981-	Soil Scientist, USDA-ARS, Hydrology Laboratory, Beltsville, MD

Membership in Professional Societies:

American Society of Agronomy
American Society of Soil Science
American Society of Agricultural Engineers
American Geophysical Union

Offices and Committee Assignments Held in Professional and Honorary Societies:

Served on ASAE's task force on Ground Water in Relation to Agriculture (1988)
Organized and chaired a symposium on Preferential Flow, sponsored by ASAE, ASA, SSSA, AGU, and ASCE (1991)
Co-chaired USDA Beltsville Symposium, Agricultural Water Quality Priorities (1992)
USDA-ARS representative, Interagency Task Force for Monitoring (ITFM) Water Quality (1994)
Chaired Soil Physics (S-1) sessions for SSSA national mts. (1988, and 1990)

Honors and Awards:

Awarded post-doctoral research associate (1989)
USDA Certificate of Merit/Outstanding Performance Awards 1990, 1991, 1992, 1993

Refereed Publications Since 1991:

Gish, T. G., C. S. Helling, and M. Mojasevic. Preferential Movement of atrazine and cyanazine under field conditions. Transactions ASAE 34:1699-1705. 1991.

Wienhold, B. J. and T. J. Gish. Enzymatic pretreatment for extraction of starch encapsulated pesticides from soil. Weed Sci. 39:423-426. 1991.

Gish, T. J., M. J. Schoppet, C. S. Helling, A. Shirmohammadi, M. M. Schreiber, and R. E. Wing. Transport comparison of technical grade and starch-encapsulated atrazine. Transactions ASAE 34:1738-1744. 1991.

Rawls, W. J., T. J. Gish, and D. L. Brakensiek. Estimating soil water retention from soil physical properties and characteristics. Advances in Soil Sci. 16:213-230. 1991.

Gish, T. J., A. R. Isensee, R. G. Nash, and C. S. Helling. Impact of preferential transport on water quality. Transactions ASAE 34:1745-1753. 1991.

Wienhold, B. J. and T. J. Gish. Effect of water potential, temperature and soil microbial activity on release of starch encapsulated atrazine and alachlor. J. Environ. Qual. 21:382-386. 1992.

Mojašević, M., C. S. Helling, T. J. Gish, and I. S. Gojković. Pokretljivost pesticida u zemljištu (III) Distribucija etoprofosa, karbofurana, atrazina, metribuzina i cijanazina u praškastoj ilovači. Pesticidi 7:125-144. 1992.

Wienhold, B. J., A. M. Sadeghi, and T. J. Gish. Effect of starch encapsulation and temperature on volatilization of atrazine and alachlor. J. Environ. Qual. 22:162-166. 1993.

Gish, T. J. and A. Sadeghi. Agricultural water quality priorities: A symposium overview. J. Environ. Qual. 22:389-391. 1993.

Wienhold, B. J., and T. J. Gish. Effect of Formulation and tillage practice on volatilization of atrazine and alachlor. J. Environ. Qual. 23:292-298. 1994.

Gish, T. J., A. Shirmohammadi, and B. J. Wienhold. Field-scale

mobility and persistence of commercial and starch-encapsulated atrazine and alachlor. J. Environ. Qual. 23:355-359. 1994.

Wienhold, B. J. and T. J. Gish. Chemical properties influencing rate of release of starch encapsulated herbicides: implications for modifying environmental fate. Chemoshere 28:1035-1046. 1994.

Gish, T. J., A. Shirmohammadi, L. McKee, B. J. Wienhold, and R. Vyravipillai. Leaching of herbicides under conventional and no-tillage practices. Accepted May 14, 1994, Soil Sci. Soc. Am. J. 1994.

I. Karen S. Humes, Hydrologist

II. CRIS Projects:

Old CRIS Project 1270-13660-003-00D: Remote Sensing in Hydrology
New CRIS Project 1270-13660-005-00D: Remote Sensing for Hydrology

Objective: The synergistic use of a number of remotely sensed data types to estimate spatially-distributed parameters and state variables will be used for surface energy balance modeling.

Progress: Coordinated ground and aircraft-based remote sensing measurements acquired during large-scale field experiments were used to determine that aircraft-based land surface temperatures, after atmospheric correction, were within 1° C of ground-based temperatures over a semi-arid watershed. The aircraft-based images provide a very high level of spatial and temporal resolution in land surface temperature, which allows the study of spatial and temporal variability in an important land surface parameter.

Plans: The synergistic use of both optical and microwave remotely sensed data will be pursued through analysis and synthesis of combined data sets from field to watershed scale over a variety of landuses. Laser altimeter data from large-scale field experiments over semi-arid and sub-humid watersheds will be used to improve algorithms for deriving spatially-distributed vegetation and surface roughness parameters from local to regional scales. Multi-year satellite data sets will be used together with precipitation data available over experimental watersheds to monitor relationships between precipitation, air temperature, vegetation density and conditions.

Old CRIS Project 1270-13610-002-00D: Quantification/Integration of Basin Scale Hydrologic Fluxes
New CRIS Project 1270-13610-004-00D Hydrologic and Climate Processes at Basin Scale

Objectives: To use remotely sensed data to quantify the heterogeneity of the land surface, the application of spatially-distributed models of surface water and energy balance; to improve the understanding of spatial scaling of surface fluxes; to use remotely sensed data to quantify the impact of surface heterogeneity on atmospheric and climatic processes, including feedback effects.

Progress: A combination of ground and aircraft-based remotely sensed data acquired over a semi-arid watershed were found to be useful in estimating spatially-distributed surface energy balance

components. Estimates of surface energy fluxes compared favorably (within measurement errors of ground-based instrumentation) with ground-based flux measurements under most field conditions. However, errors in spatially extending point-based ground meteorological measurements, particularly incoming solar radiation, were found to be a limiting factor in estimating spatially-distributed fluxes under partly cloudy conditions. The estimation of spatially-distributed surface energy fluxes with remotely sensed data is critical for mproving estimates of the water balance at basin scales and improving the understanding of the interactions of land-surface heterogeneities with atmospheric processes and climate.

The mean and standard deviation of vegetation height and density across a watershed determined with laser altimeter data were found to agree well with ground-truth maps of shrub/grass transitions in a semi-arid watershed. These data provide one of the only means of estimating vegetation parameters (such as height and density) which are very important to surface energy balance models.

Plans: Physically-based models of moisture and energy balance driven by both optical and microwave remotely sensed data will be validated at the field scale and extended spatially across a watershed. Existing models which include a simple 1-D parameterization of the planetary boundary layer will be utilized to quantify the effects of atmospheric feedback on surface fluxes. These models will be employed on a pixel-by-pixel basis through the use of a Geographic Information System (GIS).

A number of remotely sensed data types from new and existing field experiment data sets will be synthesized into spatially-distributed field of soil moisture, surface temperature and energy fluxes at the watershed scale, to be used as boundary conditions in 3-dimensional, physically-based models of atmospheric processes (e.g., large-eddy simulation models) to better understand and quantify the effect of land-surface heterogeneity on atmospheric and climatic processes. The utility of spatially-distributed parameters derived from remotely sensed data, such as vegetation, soil moisture, and surface roughness parameters, will be evaluated for use in hydrologic models.

III. Cooperators:

ARS Beltsville:

Craig Daughtry, Remote Sensing Laboratory, USDA-ARS, Beltsville, MD.

ARS:

M.S. Moran, U.S. Water Conservation Laboratory, Phoenix, AZ

D.C. Goodrich, Southwest Watershed Research Center, Tucson, AZ
Mark Weltz, Southwest Watershed Research Center, Tucson, AZ
Frank Schiebe and Pat Starks, National Agricultural Water Quality Laboratory, Durant, OK
John Prueger, National Soil Tilth Laboratory, Ames, IA

<u>Other:</u>

Larry Hipps, Utah State University,Logan, UT
Dave Stannard, U.S. Geological Survey, Denver, CO
Dave Nichols, U.S. Geological Survey, Carson City, NV
Soroosh Sorooshian, University of Arizona, Tucson, AZ
John Stewart, Institute of Hydrology, Nottingham, UK
H.A.R. de Bruin, Wageningen Agricultural University, The Netherlands
Massimo Menenti, Wageningen Staring Center, The Netherlands
Alain Vidal, CEMEGREF, Montpelier, France
Odile Taconet, CRPE, France

III. Curriculum Vitae:

<u>Education</u>:

1979	B. S. Geophysics, New Mexico Institute of Mining and Technology
1986	M. S. Soil Science, University of Arizona
1992	Ph.D. Hydrology, University of Arizona

<u>Professional Employment</u>:

1979-1984	Engineer/Technical Group Supervisor, Jet Propulsion Laboratory, California Institute of Technology
1984-1987	Graduate Research/Teaching Assistant, University of Arizona, Dept. of Soil and Water Science
1988-1991	NASA Graduate Student Research Program Fellow, Dept. of Hydrology and Water Resources, University of Arizona
1992-1993	Postdoctoral Research Associate, Hydrology Laboratory, USDA/ARS, Beltsville, MD
1993-	Hydrologist, Hydrology Laboratory, USDA/ARS, Beltsville, MD

<u>Membership in Professional Societies</u>:

American Geophysical Union

<u>Offices and Committee Assignments Held in Professional and Honorary Societies</u>:

Deputy Chair, American Geophysical Union, Committee on Large-Scale Field Experiments
Program Committee, American Meteorological Society, Session on

Hydrometeorology, 1995 Annual Meeting
National Research Council/National Academy of Sciences Science Panel on GEWEX (Global Energy and Water Experiment)

Awards:

USDA Certificate of Merit/Outstanding Performance Awards 1992 1993
NASA Graduate Student Researcher Fellowship, 1988-92
John and Margaret Harshbarger Award for Outstanding Ph.D. Student, Department of Hydrology and Water Resources, University of Arizona, 1988
Gamma Sigma Delta, Agricultural Honor Society, Outstanding Graduate Student, College of Agriculture, University of Arizona, 1986
American Society of Photogrammetry, William A. Fischer Memorial Scholarship for graduate studies addressing new and innovative uses of remote sensing of natural resources, 1985
Estwing Award for Outstanding Geoscience Graduate, Class of 1979, New Mexico Institute of Mining and Technology

Refereed Publications Since 1991:

Kustas, W.P., D.C. Goodrich, M.S. Moran, S.A. Amer, L.B. Bach, J.H. Blanford, A. Chehbouni, H. Claassen, W.E. Clements, P.C. Doraiswamy, P. Dubois, T.R. Clarke, C.S.T. Daughtry, D.I. Gellman, T.A. Grant, L.E. Hipps, A.R. Huete, K.S. Humes, T.J. Jackson, T.O. Keefer, W.D. Nichols, R. Parry, E.M. Perry, R.T. Pinker, P.J. Pinter, Jr., J. Qi, A.C. Riggs, T.J. Schmugge, A.M. Shutko, D.I. Stannard, E. Swaitek, J.D. van Leeuwen, J. van Zyl, A. Vidal, J. Washburne, and M.A. Weltz, An Interdiscplinary field study of the energy and water fluxes in the atmosphere-biosphere system over semiarid rangelands: description and some preliminary results, Bull. Am. Meterol. Soc., 72, 1683-1705, 1991.

Kustas, W.P., T.J. Schmugge, K.S. Humes, M.A. Weltz, T.J. Jackson and R. Parry, Relationships between evaporative fraction and remotely sensed vegetation index and microwave brightness temperature for semiarid rangelands, Journal of Applied Meteorology, 32:1781-1790, 1993.

Humes, K. S., W. P. Kustas, M. S. Moran, W. D. Nichols and M. A. Weltz, Variability in emissivity and surface temperature over a sparsely vegetated surface, Water Resources Research, 30:1299-1310, 1994.

Humes, K. S., W. P. Kustas and M. S. Moran, Use of remote sensing data and reference site measurements to estimate instantaneous surface energy balance components over a semi-arid rangeland watershed, Water Resources Research, 30:1363-1373, 1994.

Kustas, W. P., M. S. Moran, K. S. Humes, D. I. Stannard, P. J. Pinter, Jr., L. E. Hipps, E. Swiatek and D. C. Goodrich, Surface energy balance estimates at local and regional scales using optical remote sensing from an aircraft platform and atmospheric data collected over semiarid rangelands, Water Resources Research, 30:1241-1259, 1994.

Kustas, W.P., W.T. Pinker, T.J. Schmugge and K.S. Humes, Daytime net radiation estimated for a semiarid rangeland basin using remotely sensed data, Agricultural and Forest Meteorology, accepted 10/93.

Stewart, J.B., W.P. Kustas, K.S. Humes, W.D. Nichols, M.S. Moran and H.A.R. deBruin, Sensible heat flux-radiometric surface temperature relationship for eight semi-arid areas, Journal of Applied Meteorology, accepted 2/94.

Kustas, W.P., L.E. Hipps and K.S. Humes, Calculation of basin scale surface fluxes by combining remotely sensed data and atmospheric properties in a semiarid landscape, Boundary Layer Meteorology, accepted 8/94.

I. Thomas J. Jackson, Hydrologist

II. CRIS Projects:

Old CRIS Project 1270-13660-003-00D: Remote Sensing in Hydrology
New CRIS Project 1270-13660-005-00D: Remote Sensing for Hydrology

Objective: Investigate the use of multitemporal and spatially distributed passive and active microwave data for measuring soil moisture over large areas.

Progress: A multibeam aircraft passive microwave radiometer utilizing new synthetic aperture technology was built and installed on a NASA aircraft as part of a cooperative project with NASA and validated in several large scale experiments. The verification and demonstration of this technology is extremely important to providing a solution to the key problem of using this type of sensor in space.

Plans: Passive and active microwave sensors will be employed to evaluate the use of multitemporal and spatially distributed estimates of soil moisture in hydrologic investigations. This research will have two major thrusts. One of these will be conducting aircraft based experiments involving concurrent time series of both active and passive microwave data. These data will be used to develop improved soil moisture algorithms and to explore the direct integration of data in hydrologic models. The other focus will be limited space based experimentation will be conducted using current and planned active and passive microwave sensors.

Old CRIS Project 1270-13610-002-00D: Quantification and Integration of Basin Scale Hydrologic Fluxes
New CRIS Project 1270-13610-004-00D: Hydrologic and Climate Processes at Basin Scale.

Objective: Integration of multifrequency remotely sensed data and water and energy balance modelling for profile soil moisture estimation at point and regional scales.

Progress: A dual frequency passive microwave radiometer system was developed with cooperators specifically for soil moisture research, initial studies have revealed important new information on the diurnal behavior of the soil surface layer. This information is very important and will help develop linkages between the surface observations and the profile condition as well as evaporative fluxes.

Plans: Data will be collected using a dual frequency passive microwave radiometer and other instruments covering the visible, near infrared and thermal regions of the spectrum over controlled

condition sites. Meteorological and energy balance parameters will be monitored in conjunction with the water balance in the soil column. Experiments will involve high temporal resolution observations of diverse cover conditions and climates. With cooperators, these data will be used in a physically based modelling approach based on Kalman filtering to develop procedures for extrapolating surface observations through the soil profile over large regions.

III. Cooperators:

ARS:

Frank Schiebe, USDA-ARS Water Quality Lab, Durant, OK
David Goodrich, USDA-ARS, Southwest Watershed Research Unit, Tucson, AZ
USDA-ARS Remote Sensing Research, Weslaco, TX

Other:

Edwin T Engman, NASA Goddard Space Fight Center, Greenbelt, MD
Peggy E. O'Neill, NASA Goddard Space Flight Center, Greenbelt, MD
David M. Le Vine, NASA Goddard Space Flight Center, Greenbelt, MD
Calvin T. Swift, University of Massachusetts, Dept. of Electrical and Computer Engineering, Amherst, MA
Dara Entekhabi, Massachusetts Institute of Technology, Dept. of Civil Engineering, Cambridge, MA
Eni Njoku, NASA Jet Propulsion Laboratory, Pasadena, CA
Kosta G. Kostov, Bulgarian Academy of Sciences, Sofia, Bulgaria
Anatolij M. Shutko, Russian Academy of Sciences, Moscow, Russia
Eric Wood, Princeton University, Dept. of Civil Engineering, Princeton, NJ

IV. Curriculum Vitae:

Education:

1971	B.S. Fire Protection Engineering, University of Maryland
1973	M. S. Civil Engineering, University of Maryland
1976	Ph.D. Civil Engineering, University of Maryland

Professional Employment:

1976-1977	Assistant Professor, University of Kentucky, Lexington, KY
1977-	Hydrologist, USDA, ARS, Hydrology Lab, Beltsville, MD

Membership in Professional Societies:

American Geophysical Union
Institute of Electrical and Electronics Engineers
Geoscience and Remote Sensing Society

Offices and Committee Assignments Held in Professional and Honorary Societies:

American Society of Civil Engineers, Assistant News Editor 1977-1980
American Society of Photogrammetry, Second Deputy, Hydrospherics Committee, 1980
American Society of Photogrammetry, First Deputy, Hydrospherics Committee, 1981
American Society of Photogrammetry, Chairman, Hydrospherics Committee, 1982.
American Geophysical Union, Remote Sensing for the Hydrologic Sciences, Committee, Member, 1978-1990
American Geophysical Union, Remote Sensing for the Hydrologic Sciences Committee, Chairman, 1980-1984
American Geophysical Union, Surface Water Hydrology Committee, Member, 1980-1982
American Geophysical Union, Large Scale Experimentation in Hydrology Committee, Member, 1984-1988

Awards:

USDA Certificate of Merit/Outstanding Performance Awards 1990 1991 1992 1993
American Society of Agricultural Engineers Paper Award for "Airborne Laser Measurements of the Surface Topography of Simulated Concentrated Flow Gullies, 1990

Refereed Publications Since 1991:

Jackson, T. J. and O'Neill, P. E. Microwave emission and crop residues. Remote Sensing of Environment, 36:129-136. 1991.

Jackson, T. J. and Schmugge, T. J. Vegetation effects on the microwave emission of soils. Remote Sensing of Environment, 36:203-212. 1991.

Kustas, W. P., Goodrich, D.C., Moran, M. S., Amer, S. A., Bach, L. B., Blanford, J. H., Chehbouni, A., Claassen, H., Clements, W. E., Doraiswamy, P. C., Dubois, P., Clarke, T. R., Daughtry, C. T., Gellman, D., Grant, T. A., Hipps, L. E., Huete, A. R., Humes, K. S., Jackson, T. J., Keefer, T. O., Nicols, W. D., Parry, R., Perry, E. M., Pinker, R. T., Pinter, P. J. Jr., Qi, J., Riggs, A. C., Schmugge, T. J., Shutko, A. M., Stannard, D. L., Swiatek, E., van Leeuwen, J. D., van Zyl, J., Vidal, A., Washburne, J. and

Weltz, M. A. An interdisciplinary field study of the energy and water fluxes in the atmosphere-biosphere system over semiarid rangelands: description and some preliminary results. Bulletin of the American Meteorological Society, 72(11):1683-1705. 1991.

Jackson, T. J., Shutko, A. M., Shiue, J. C., Schmugge, T. J., Davis, D. R., Parry, R., Haldin, A., Reutov, E. Novichikhin, E., Liberman, B., Kustas, W. P., Goodrich, D. C., Amer, S., Bach, L. and Ritchie, J. C. Multifrequency passive microwave sensors observations of soil moisture in an arid rangeland environment. International Journal of Remote Sensing, 13:573-580. 1992.

Ritchie, J. C., Everitt, J. H., Escobar, D. E., Jackson, T. J. and Davis, M. R. Airborne laser measurements of rangeland canopy cover and distribution. Journal of Rangeland Management, 45(2):189-193. 1992.

Ritchie, J. C., Jackson, T. J., Everitt, J. H., Escobar, D. E., Murphey, J. B., and Grissinger, E. H. Airborne laser: a tool to study landscape surface features. Journal of Soil and Water Conservation, 47(1):104-107. 1992.

Jackson, T. J., Kostov, K., and Saatchi, S. S. Rock fraction effects on the interpretation of microwave emission from soils. IEEE Trans. on Geoscience and Remote Sensing, GE-30:, 1992.

Schmugge, T. J., Jackson, T. J. Kustas, W. R. and Wang, J. R. Passive microwave remote sensing of soil moisture: results from HAPEX, FIFE and MONSOON 90. ISPRS Journal of Photogrammetry and Remote Sensing, 47:127-143. 1992.

Schmugge, T. J. and Jackson, T. J. Dielectric model of the vegetation effects on the microwave emission from soils. IEEE Trans. on Geoscience and Remote Sensing, 30:757-760. 1992.

Jackson, T. J. Measuring surface soil moisture using passive microwave remote sensing. Hydrological Processes, 7:139-152. 1993.

O.Neill, P. E., Jackson, T. J., Chauhan, N. S., and Seyfield, M. S. Microwave soil moisture estimation in humid and semiarid watersheds. Advances in Space Research, 13(5):115-118. 1993.

Wood, E. F., Lin, D., Mancini, M., Thongs, D., Troch, P., Jackson, T. J., and Engman, E. T. Intercomparisons between passive and active microwave remote sensing and hydrological modelling for soil moisture. Advances in Space Research, 13(5):167-176. 1993.

Kostov, K. G. and Jackson, T. J. Estimating profile soil moisture from surface layer measurements-a review. SPIE Vol. 1941 Ground Sensing:125-136. 1993.

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Schmugge, T., Jackson, T. J., Kustas, W. P., Roberts, R., Parry, R., Goodrich, D. C., Amer, S. A., and Weltz, M. A. Push broom microwave radiometer observations of surface soil moisture in Monsoon '90. Water Resources Research, 30:1321-1328. 1994.

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Schmugge, T. J. and Jackson, T. J. Passive microwave remote sensing of soil moisture. Advances in Remote Sensing, in press. 1994.

Schmugge, T. J. and Jackson, T. J. Mapping surface soil moisture with microwave radiometers. Meteorology and Atmospheric Physics, in press. 1994.

I. William P. Kustas, Hydrologist

II. CRIS Projects:

Old CRIS Project 1270-13610-002-00D: Quantification and Integration of Basin Scale Hydrologic Fluxes
New CRIS Project 1270-13610-004-00D: Hydrologic and Climate Processes at Basin Scale

Objective: Investigate techniques for quantifying basin scale fluxes by developing models that utilize remote sensing data with atmospheric inputs at local (i.e., weather station data) and regional (i.e., atmospheric boundary layer data) scales. Evaluate the fluxes and state variables such as surface temperature and soil moisture computed by processed-based models with data collected from large scale multidisciplinary field experiments.

Progress: The quantification of basin scale fluxes with Atmospheric Boundary Layer (ABL) and remote sensing data was evaluated in semiarid watersheds. One method utilizing wind and temperature data in the ABL in conjunction with remote sensing observations yielded values which were within 15% of the ground-based network of measured fluxes. However, model sensitivity to possible variation in key model parameters was found to be fairly significant. Application of integrated simplified conservation equations resulted in estimates of regional fluxes that were within 20% of the measured values but require a method to account for horizontal advection. Both techniques have significantly improved the estimation of surface fluxes at a regional scale; thus allowing for better large scale water management.

Plans: Techniques will be developed to combine multifrequency measurements with energy balance models of varying complexity related to the parameterization of the surface-atmosphere exchanges. Fluxes will be computed from local to regional scales and compared to a network of ground-based measurements. Models simulating the soil-vegetation-atmosphere system will have as output the energy fluxes and important state variables, such as surface temperature and soil moisture which can be compared to flux and remote sensing observations. The latter comparison between model-derived and remotely sensed state variables will assist in understanding the issues related to the scaling of processes and parameters.

Old CRIS Project 1270-13660-003-00D: Remote Sensing in Hydrology
New CRIS Project 1270-13660-005-00D: Remote Sensing for Hydrology

Objective: Develop techniques for combining multifrequency remote sensing data which will provide important information for

water and energy balance models. These include soil moisture estimates from microwave sensors, vegetation cover from visible and near-IR, surface temperature from thermal-IR, and vegetation height, density and local and regional roughness from laser-altimeter data. All this information will be integrated into models for computing spatial distributed fluxes and permit the integration of the fluxes to larger scales.

Progress: Remotely sensed data in the visible, near-IR and thermal-IR were combined in a model to extrapolate fluxes measured at a reference site to other locations in the watershed. Results were in satisfactory agreement with measured fluxes at other locations (i.e., with 20%, on average). The analysis indicated significant errors can result from the assumptions in the model, which were violated when flux estimates were extrapolated to a different ecosystem and when the model was used under partly cloudy conditions. The feasibility of providing important quantities such as the fraction of available energy used for evaporation by utilizing optical and microwave measurements over semi-arid rangelands was explored. These results have provided a strong conceptual and experimental foundation for development of algorithms within large scale hydrologic and atmospheric models to use this unique spatial information.

Plans: The utility of remote sensing from the visible to microwave wavelengths collected from small scale experimental plots and from large scale field experiments such as Monsoon '90, Washita '92, to provide spatial information relevant to scaling energy and water fluxes and processes from local to basin scale will be evaluated. Integration of remotely sensed soil moisture, vegetation cover, surface roughness and surface temperature into hydrologic and atmospheric models will be the primary focus of the research. This will result in making optimal use of both data and model simulations.

III. Cooperators:

<u>ARS Beltsville</u>:

Craig Daughtry, Remote Sensing Research Laboratory, USDA-ARS, Beltsville, MD

<u>ARS</u>:

M. Susan Moran, Mark Weltz and David Goodrich, Southwest Watershed Research Center, Tucson, AZ
Gerald Flerchinger, Northwest Watershed Research Center, Boise, ID

Other:

Larry Hipps, Utah State University, Logan, UT
Rachel Pinker, University of Maryland, College Park, MD
Toby N. Carlson and Rob R. Gillies, Pennsylvania State University, University Park, PA
David I. Stannard, U.S. Geological Survey-Water Resources Division, Denver, CO
John Stewart, Institute of Hydrology, Wallingford, UK
Pablo Huq, University of Delaware, Newark, DE

IV. Curriculum Vitae:

Education:

1981 B.S. Forest Engineering, State University of New York College of Environmental Science and Forestry
1983 M.S. Civil Engineering, Cornell University
1986 Ph.D. Civil Engineering, Cornell University

Professional Employment:

1986- Hydrologist, Hydrology Laboratory, USDA-ARS Beltsville, MD

Memberships in Professional Societies:

American Geophysical Union
American Meteorological Society

Professional Advisory and Consulting Activities:

Member of the STORM (Stormscale Operational and Research Meteorology)-Related Hydrology Steering Group (1989)
Group leader of the Remote Sensing for Hydrology team at the ARS Conference on Watershed Management held in Denver, CO., September 13-14, 1993
Team Leader of the working group on "Present and Future Applications of Thermal Remote Sensing" for the international workshop, "Thermal Remote Sensing of the Energy and Water Balance over Vegetation in Conjunction with Other Sensors" held in La Londe, France 23 September, 1993
Principle investigator of the NASA-funded interdisciplinary project, "Water and Energy Balance of a Semiarid Rangeland during the Summer 'Monsoon' Season" 1990-1993

Offices and Committee Assignments Held In Professional and Honorary Societies:

Member of the NCR-160 Committee "Efficient Use of Water by Vegetation in Great Plains Environment" 1989-1993

Member of the American Meteorological Society Committee on Hydrology 1989-93
Member of the American Geophysical Union Hydrology Section Remote Sensing Committee 1992-present
Chair of the American Meteorological Society Committee on Hydrology 1993-present
Program Chair of the Spring Meeting of the American Geophysical Union Hydrology Section 1994-1995

Honors and Awards:

USDA Certificate of Merit/Outstanding Performance Award, 1990
Awarded ARS Administrator Post Doctoral Research Position, 1990
USDA Certificate of Merit/Superior Performance Award, 1991, 1992

Refereed Publications Since 1991:

Kustas, W.P., Goodrich D.C, Moran M.S., et al. An interdisciplinary field study of the energy and water fluxes in the atmosphere- biosphere system over semiarid rangelands: Description and some preliminary results, Bull. Amer. Meteorol. Soc., 72, 1683-1705. 1991.

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Nie, D., Kanemasu, E.T., Fritschen, L.J., Weaver, H.L., Smith, E.A., Verma, S.B., Field, R.T., Kustas, W.P., and Stewart, J.B. An intercomparison of surface energy flux measurement systems used during FIFE 1987. J. Geophysic. Res. 97:18,715-18,724. 1992.

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Humes, K.S., Kustas W.P., and Moran M.S. Use of remote sensing and reference site measurements to estimate instantaneous surface energy balance components over a semi-arid rangeland watershed. Water Resour. Res. 30:1363-1373. 1994.

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Stannard, D.I., Blanford, J.H., Kustas, W.P., Nichols W.D., Amer, S.A., Schmugge T.J., and Weltz, M.A. Interpretation of surface-flux measurements in heterogeneous terrain during the MONSOON 90 experiment. Water Resour. Res. 30:1227-1239. 1994.

Kustas, W.P., Rango, A., and Uijlenhoet, R. A simple energy budget algorithm for the Snowmelt Runoff Model (SRM). Water Resour. Res. 30:1515-1527. 1994.

Kustas, W.P., Perry, E.M., Doraiswamy, P.C., and Moran, M.S. Using satellite remote sensing to extrapolate evapotranspiration estimates in time and space over a semiarid rangeland basin. Remote Sensing of Environment. Accepted 2/94.

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Stewart, J.B., Kustas, W.P., Humes, K.S., Nichols, W.D., Moran, M.S., and de Bruin, H.A.R. Sensible heat flux-radiometric surface temperature relationship for 8 semi-arid areas, Journal of Applied Meterology. Accepted 2/94.

Kustas, W.P., Hipps, L.E. and Humes, K.S., Calculation of Basin Scale Surface fluxes by combining remotely sensed data and atmospheric properties in a semiarid landscape, Boundary-Layer Meteorology. Accepted 8/94.

I. Albert Rango, Hydrologist

II. CRIS Projects:

Old CRIS Project 1270-13000-005-00D: Hydrologic Processes Related to Water Quantity and Quality
New CRIS Project 1270-13000-006-00D: Environmental Hydrology

Objective: Develop improved snowmelt runoff forecast procedures incorporating remote sensing measurements.

Progress: The Snowmelt-Runoff Model (SRM) has now been tested on over 60 basins in 19 different countries, and the simulation performance has been outstanding. Various algorithms have been continually added to SRM to improve performance, and a User's Manual had been published to assist in application of the model and explain how remote sensing input is used. A first workshop covering the use of SRM in various snowmelt applications was held and a microcomputer version of SRM has been widely distributed. Initial tests of a radiation balance component algorithm for SRM for calculating snowmelt were successful. SRM can be used with confidence by a wide spectrum of users for simulation, forecasting, ground verification and research applications such as climate change assessments.

Plans: Complete development of radiation balance component, test on entire basins, and combine with the degree day approach in SRM. Update the User's Manual to include the radiation balance algorithm and climate change algorithms. Conduct a second workshop tailored to applications in developing countries.

Old CRIS Project 1270-13660-003-00D: Remote Sensing in Hydrology
New CRIS Project 1270-13660-005-00D: Remote Sensing for Hydrology

Objective: Investigate passive and active microwave data for estimating snow water equivalent and develop an integrated modular system for handling satellite remote sensing data for use in snow hydrology applications.

Progress: When using passive microwave techniques to monitor snow cover, the objective is to produce basinwide snow water equivalent estimates. It has been discovered that it is important to include knowledge of snow grain size; otherwise, large discrepancies in snow water equivalent estimates may result if abnormal grain sizes are present. Large differences in microwave response in various subbasins of the Upper Colorado River Basin were traced back to vastly different grain sizes between subbasins. Similar differences have been noted in monitoring the snow accumulation on the western half of the North American continent. Results indicate that conventional snow

depth reports may be used as an indicator of grain size which will allow operational use of the passive microwave data.

A prototype Alpine Snow Cover Analysis System (ASCAS) was developed for operation on microcomputers. ASCAS integrates image processing, geographic information systems, database systems, snowmelt runoff modeling, and scientific visualization on one microcomputer. NOAA-AVHRR is presently the main satellite data source because of the frequent coverage available. The microcomputer approach, as opposed to operation on larger, more expensive and nondedicated systems has much appeal for hydroelectric power companies, irrigation districts, and other small users who need economical, yet powerful processing systems where both snow mapping and snowmelt runoff forecasting can be conducted.

Plans: Additional data sets will be acquired to test the hypothesis that snow depth records in the winter accumulation period can be used to estimate the average grain size. Years with low and high accumulation in various western basins will be selected. A method will be developed to come up with estimates of below average, average, and above average snow grain sizes and subsequently to use this information to correct microwave retrieval algorithms used to estimate snow water equivalent. Satellite microwave data from the SSM/I sensor will be used. Active microwave data from satellite sensors will be acquired to determine if these data will be useful for snowpack characterization during snowmelt.

Total integration of the five modules will be completed to allow efficient transfer of data. Snow mapping and forecasting will be carried out on several basins in the United States and Europe to demonstrate capabilities.

Old CRIS Project 1270-13610-002-00D: Quantification and Integration of Basin Scale Hydrologic Fluxes
New CRIS Project 1270-13610-004-00D: Hydrologic and Climate Processes at Basin Scale

Objective: Employ the Snowmelt Runoff Model under conditions of climate change to assess the hydrologic response of snowmelt basins.

Progress: SRM was used to assess the hydrologic response of western North American mountain basins to various climate change scenarios. An increase in mean annual temperature causes a redistribution of snowmelt runoff within the snowmelt season and from the summer half year to the winter half year. The months April and May gain much runoff at the expense of June-August. On some basins the winter half-year flow rises from 14% to 30% of the annual flow (summer half-year flow decreases from 86% to

70%). A widening of the gap between water supply and water demand is evident, and SRM generated scenarios can be used by water management agencies to guide their response to climate change.

Plans: More complete climate change and hydrologic response scenarios will be developed to include changes in precipitation and snowpack extent and volume. Combined with the temperature increase, these changes will be used to generate changes in snow cover depletion. The hydrologic response to climate change will be evaluated for low, average, and high runoff years for basins in different regions of western North America and other parts of the world. A workshop will be organized to develop guidelines on how to use hydrologic models in climate change analyses, how to obtain consistent climate change data sets for input to models, and how to compare the results of different models.

III. Cooperators:

ARS Beltsville:

William Wergin, USDA-ARS, Electron Microscopy Laboratory, Beltsville, MD

ARS:

Keith Cooley, USDA-ARS, Northwest Watershed Research Center, Boise, ID

Others:

George Leavesley, USGS, Water Resources Division, Denver, CO
Ed Josberger, USGS, Snow and Ice Project, Tacoma, WA
Al Chang, NASA Goddard Space Flight Center, Greenbelt, MD
Dave McIntosh, Electric Power Research Institute, Palo Alto, CA
Richard Armstrong, Snow and Ice Data Center, University of Colorado, Boulder, CO
Jaroslav Martinec, Consulting Hydrologist, Davos, Switzerland
Michael Baumgartner, Department of Geography, University of Berne, Switzerland
Geoff Kite, National Hydrologic Research Institute, Saskatoon, Saskatchewan, Canada
James Miller, Rutgers University, New Brunswick, NJ
Larry Smith, Department of Geological Sciences, Cornell University, Ithaca, NY
Peter Gleick, Pacific Institute, Oakland, CA
John Rodda, World Meteorological Organization, Geneva, Switzerland

IV. Curriculum Vitae:

Education:

1965	B.S. Meteorology, Penn State University
1967	M.S. Meteorology, Penn State University
1969	Ph.D. Watershed Management, Colorado State University

Professional Employment:

1969-1972	Assistant Professor, Department of Meteorology, Penn State University, University Park, PA
1972-1983	Research Hydrologist and Branch Head, Hydrological Sciences Branch, NASA Goddard Space Flight Center, Greenbelt, MD
1983-1993	Research Hydrologist and Research Leader, Hydrology Laboratory, Agricultural Research Service, Beltsville, MD
1993-	Research Hydrologist, Hydrology Laboratory, Agricultural Research Service, Beltsville, MD

Membership in Professional Societies:

International Association of Hydrological Sciences (IAHS)
American Geophysical Union (AGU)
American Water Resources Association (AWRA), Fellow
American Meteorological Society (AMS)
Western Snow Conference (WSC), Life Member

Offices and Committee Assignments Held in Professional Societies:

IAHS: Vice President (President-Elect), International Committee on Remote Sensing and Data Transmission (ICRSDT) 1987-1995; Chairman, International Commission on Snow and Ice (ICSI), Working Group on Large Scale Snow Studies

AGU: Chairman, Snow and Ice Committee; Member, Committees on Remote Sensing for the Hydrological Sciences, Soviet Hydrology, and Public Affairs; Member Hydrology Section Executive Committee

AWRA: President 1986; President-Elect 1985; Vice President 1984; and Secretary 1983

AMS: Member, Hydrology Committee

WSC: General Chairman, 1990-1992

U.S. National Committee on Scientific Hydrology - Member
U.S. National Committee for IAHS - Chairman, 1991-1995
U.S. National Committee for the International Union for Geodesy and Geophysics - Member
U.S. National Representative for IAHS
U.S. National Representative for ICRSDT and ICSI

World Meteorological Organization-Rapporteur on Remote Sensing for Hydrological Purposes and Rapporteur on Applications of Remote Sensing

Awards:

USDA Certificate of Merit/Outstanding Performance Awards, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993
Western Snow Conference Best Paper Award, 1987
NASA Exceptional Service Medal, 1974
Colorado State University Professional Achievement Award, 1974

Refereed Publications Since 1991:

Chang, A.T.C., Foster, J.L. and Rango, A. Utilization of surface cover composition to improve the microwave determination of snow water equivalent in a mountain basin, International Journal of Remote Sensing, 12(11):2311-2319. 1991.

Foster, J.L., Chang, A.T.C., Hall, D.K. and Rango, A. Derivation of snow water equivalent in boreal forests using microwave radiometry, Arctic, 44:147-152. 1991.

Baumgartner, M.F. and Rango, A. Snow cover mapping using microcomputer image processing systems, Nordic Hydrology, 22(4):193-210. 1991.

Zevenberger, A.W. and Rango, A. Applying Landsat imagery for groundwater development in Egypt, Geocarto International, 7(3), 1992.

Dey, B., Sharma, V.K. and Rango, A. Linear or nonlinear covariance of seasonal snowmelt and snow cover in western Himalayas, Nordic Hydrology, 23:183-192, 1992.

Rango, A. Worldwide testing of the Snowmelt Runoff Model with applications for predicting the effects of climate change, Nordic Hydrology, 23:155-172, 1992.

Chang, A.T.C., Foster, J.L., and Rango, A. The role of passive microwaves in characterizing snow cover in the Colorado River basin, GeoJournal, 26(3):381-388. 1992.

Rango, A. Workshop on remote sensing algorithms, EOS Transactions, American Geophysical Union, 73(13):147-149, 1992.

Rango, A. Snow hydrology processes and remote sensing, Hydrological Processes, 7(2):121-138. 1993.

Armstrong, R.L., Chang, A., Rango, A., and Josberger, E.G. Snow depths and grain size relationships with relevance for passive microwave studies, Annals of Glaciology, 17:171-176. 1993.

Josberger, E.G., Campbell, W.J., Gloersen, P., Chang, A.T.C., and Rango, A. A nine-year history of snow conditions in the upper Colorado River basin derived from satellite passive microwave observations, Annals of Glaciology, 17:322-326. 1993.

van Katwijk, V.F., Rango, A., and Childress, A.E. Effect of simulated climate change on snowmelt runoff modeling in selected basins, Water Resources Bulletin, 29(5):755-766, 1993.

Baumgartner, M.F. and Rango, A. A microcomputer-based alpine snow cover analysis system, Photogrammetric Engineering and Remote Sensing, 12 pp., 1994.

Rango, A. and Martinec, J. Model accuracy in snowmelt-runoff forecasts extending from 1 to 20 days, Water Resources Bulletin, 30(3):463-470, 1994.

Rango, A. Application of remote sensing methods to hydrology and water resources, Hydrological Sciences Journal, 39:10, 1994.

Rango, A. and Martinec, J. Areal extent of snow cover in a changed climate, Nordic Hydrology, 25(11), 1994.

Kustas, W.P., Rango, A., and Uijlenhoet, R. A simple energy budget algorithm for the snowmelt runoff model, Water Resources Research, 30(5), 1515-1527, 1994.

I. Walter J. Rawls, Hydrologist and Research Leader

II. CRIS Projects:

Old CRIS Project 1270-13000-005-00D: Hydrological Processes Related to Water Quantity and Quality.
New CRIS Project 1270-13000-006-00D: Environmental Hydrology

Objective: Develop parameters and processes describing the effects of preferential flow on infiltration and chemical processes

Progress: The infiltration and water balance routines for the Water Erosion Prediction Project (WEPP) model were developed, verified and successfully tested. It was found that temporal variability of bare soil infiltration decreased to a stable value after about 10 cm of rain. A procedure based on soil properties and the wetting front depth was developed for incorporating the steady state crust conductivity into the Green-Ampt hydraulic conductivity parameter. Also, a method was developed using one-dimensional infiltration procedures and Philip's geometry factor to estimate the final two dimensional infiltration rate for furrow irrigation. Work was conducted on relating effective porosity and soil structure to soil saturated hydraulic conductivity. The impact of this research has been to enable to use infiltration models for use in operational hydrology.

Plans: Continue investigating methods for predicting saturated hydraulic conductivity from readily available soils information. To use fractal geometry for describing soil porosity (microporosity and macroporosity) and use this description for predicting the soil-saturated hydraulic conductivity. To model the temporal infiltration variability caused by agricultural systems including the effects of crops, residue, bare ground, and residue. Also, investigate the temporal variability of macropore flow systems for tilled and notill practices. Evaluate the effect of micro-topography on infiltration for agricultural and rangeland.

Old CRIS Project 1270-13660-002-00D: Remote Sensing in Hydrology.
New CRIS Project 1270 13660-005-00D: Remote Sensing for Hydrology

Objective: Conduct controlled condition experimentation and dual frequency microwave instrumentation to develop methods for relating surface moisture observations to profile conditions and soil hydraulic properties.

Progress: A numerical model of water movement was developed to relate the change in soil water content of the surface soil two

days after being thoroughly wet to the mean saturated hydraulic conductivity for a range of soils. Numerous methods are available for the direct measurement of hydraulic properties of soils. Most of these methods are extremely time-consuming and expensive, especially when characterizing a large area. Alternatively, a large number of indirect methods have been derived to estimate hydraulic properties from more easily measured soil properties such as soil texture and other data routinely available from soil surveys. Recently, using numerical modeling, a method was developed to estimate average profile-saturated hydraulic conductivity based on two-day drainage. This enables the use of remote sensing of soil moisture time series to estimate soil hydraulic soil properties for large areas.

Plans: Methods using dry-down surface soil moisture series obtained using remote sensing techniques, specifically microwave or radar in conjunction with limited soil properties and numerical soil water models, will be used to derive soil hydraulic properties for large areas.

CRIS Project 0500-00032-033-00D: Minimizing Preferential Transport of Pesticides and Nitrogen to Groundwater

Objective: Develop managerial practices and chemical alternatives which will minimize preferential transport of nitrogen and pesticides.

Progress: Have been monitoring for 3 years the temporal variability of the saturated and unsaturated hydraulic conductivity in and between row for the conventional, no till and grass treatments. The temporal hydraulic properties will help describe the temporal flow of chemicals through the soil profile.

Plans: Use the hydraulic conductivity data to model the temporal changes in hydraulic conductivity and incorporate this into a model describing the movement of encapsulated herbicides and pesticides through the soil profile.

III. Cooperators:

<u>ARS Beltsville</u>:

L. J. Sikora, Soil Microbial Systems Laboratory, USDA-ARS, Beltsville, MD
A. M. Sadeghi, Environmental Chemistry Laboratory, USDA-ARS, Beltsville, MD

<u>ARS</u>:

L. R. Ahuja, ARS, Great Plains Systems Research, Fort Collins, CO
S. D. Logsdon, ARS, National Soil Tilth Laboratory, Ames, IA

J. R. Simanton, ARS, Southwest Watershed Research, Tucson, AZ

Other:

D. L. Brakensiek, Department of Agricultural Engineering, University of Maryland, College Park, MD
Adel Shirmahamadi, Department of Agricultural Engineering, University of Maryland, College Park, MD
Satish Gupta, Department Soil Science, University of Minnesota, St Paul, MN
Jim Watt, Mannaki Whenua Landcare Research, Havelock North, New Zealand

IV. Curriculum Vitae:

Education:

1966	B. S. Civil Engineering, Virginia Polytechnic Institute of Technology, Blacksburg, VA
1968	M. S. Civil Engineering, Virginia Polytechnic Institute of Technology, Blacksburg, VA
1976	Ph. D. Civil Engineering, Georgia Institute of Technology, Atlanta, GA

Professional Employment:

1969	Hydraulic Engineer, USDA-ARS, Tifton, GA
1971-1974	Hydrologist, USDA-ARS, Boise, ID
1975-1976	Staff Specialist Hydrologist, USDA-ARS, National Program Staff, Beltsville, MD
1976-1994	Hydrologist, USDA-ARS, Hydrology Lab, Beltsville, MD
1994-	Hydrologist and Research Leader, USDA-ARS, Hydrology Lab, Beltsville, MD

Membership in Professional Societies:

American Society of Agricultural Engineers (ASAE)
American Society of Civil Engineers (ASCE)
Soil Science Society of America (SSSA)

Offices and Committee Assignments Held in Professional and Honorary Societies:

Affiliate Faculty Member: Department of Agricultural Engineering, University of Idaho, Moscow, ID; Department of Civil Engineering and Agricultural Engineering, University of Maryland, College Park, MD
USDA alternate to the U.S. National Committee on Scientific Hydrology
ARS representative on the Hydrology Subcommittee, Interagency Committee on Water Data
ARS representative to the Water Resources Council Hydrology

Committee Work Group on Flood Flow Frequency for Ungauged Areas

Member of ASCE Task Force Committee to develop a report on Runoff Time Characteristics

U.S. representative on the International Hydrologic Program (UNESCO) work group on Urban Hydrology

Member ARS and SCS committee for revising SCS TR-55 "Urban Hydrology for Small Watersheds"

Member of the Technical Task Committee for the development of a North Central Water Quality Regionalization plan

Member of the American Society of Agricultural Engineers Hydrologic System Committee 1979-1985; (Vice chairman 1980-1982; Chairman 1982-1984)

Member of the American Society of Agricultural Engineers Porous Media Flow Committee 1980 - present; (Vice chairman 1983-1985; Chairman 1985-1987)

Member of American Society of Civil Engineers, (1982-1986) Hydraulics Division, Surface Water Hydrology Committee. Secretary, 1982-83; Vice chairman 1983-84; Chairman 1984-85

Member of the American Geophysical Union Surface Water Hydrology Committee 1984-1986

Member of the American Society of Agricultural Engineers Runoff and Precipitation Committee 1988 - present

Associate Editor of the Water Resources Bulletin 1988 - 1991

Associate Editor of the Transactions of the American Society of Agricultural Engineers 1988 - present

Honors and Awards:

1976 ROBERT E. HORTON Award for the most outstanding paper in the field of hydrology published in the "Water Resources Research" in 1975 entitled, "Use of Axisymmetric Infiltration Model and Field Data to Determine Hydraulic Properties of Soils"

USDA Certificate of Merit 1979 for responsiveness and leadership in conducting and completing research in a form for immediate use by the Soil Conservation Service

USDA Certificate of Merit/Outstanding performance award 1989, 1992

USDA Unit Award for Superior Service - for outstanding research, innovation, and teamwork in designing, producing, and transferring a new generation of erosion prediction technology of user agencies, 1990

USDA Certificate of Merit/Superior Performance Award 1991, 1993

Refereed Publications Since 1991:

Rawls, W. J., T. J. Gish and D. L. Brakensiek. Estimation of soil water retention from soil properties - A review. Advances in Soil Sciences 16:213-235. 1991.

Freebairn, D.M., S. C. Gupta and W. J. Rawls. Influence of aggregates, microrelief and rainfall intensity on development of surface crusts. Soil Sci. Soc. Am. J. 55:188-195. 1991.

Sharma, P. P., S. C. Gupta, and W. J. Rawls. Soil Detachment by single raindrops of varying kinetic energy. Soil Sci. Soc. Amer. J. 55:301-307. 1991.

Brakensiek, D. L. and W. J. Rawls. Comment on "Fractal processes in soil water retention" by S. W. Tyler and S. K. Wheatcraft. Water Res. Res. 28(2):601-602. 1991.

Ela, S. D., S. C. Gupta and W. J. Rawls. Macropore and surface seal interactions affecting water infiltration into soil. Soil Sci. Soc Amer. J. 56:714-721. 1992.

Rawls, W. J., L. R. Ahuja, D. L. Brakensiek and A. Shirmohaammadi. Chapter 5. Soil water movement and infiltration. Handbook of Hydrology. Editor D. R. Maidment. McGraw Hill. 1992.

Brakensiek, D. L. , W. J. Rawls, S. D. Logsdon, And W. M. Edwards. Fractal description of macroporosity. Soil Sci. Soc. Amer. J. 56:1721-1723. 1992

Rawls, W. J., D. L. Brakensiek, and S. D. Logsdon. Predicting saturated hydraulic conductivity utlizing fractal principles. Soil Sci. Soc. Amer. J. 57:1193-1197. 1993.

Brakensiek, D. L. and W. J. Rawls. Soil containing rock fragments: Effects on infiltration. Catena (accepted 1/92).

Williams, R. D., L. R. Ahuja, and W. J. Rawls. Determining the soil water characteristic with a one parameter model. Trans. Amer. Soc. Agri. Eng. 1994. (accepted 11/93)

Rawls, W. J. (ed. & coordinator). Chapter on Infiltration. Amer. Soc. of Civil Engnr. Hydrology Handbook. 1994. (accepted 10/93).

Ahuja, L. R., W. J. Rawls, and D. Nielson. Chapter - Determining soil hydraulic properties and their field variability from simpler measurements. Soil Sci. Soc. Amer. Irrigation Monograph, 1994. (accepted 7/93)

Rawls, W.J., D. L. Brakensiek, and C. A. Onstad. Seasonal Effects of soil crusts on infiltration. Australian J. Soil Research. (accepted 11/93)

Savabi, R., W. J. Rawls, and R. Knight. Water Erosion Prediction Project Rangeland Hydrology Component. J. Range Management. (accepted 12/93).

I. Jerry C. Ritchie, Soil Scientist

II. CRIS Project:

Old CRIS Project 1270-13000-005-00D: Processes Related to Water Quantity and Quality
New CRIS Project 1270-13000-006-00D: Environmental Hydrology

Objective: Evaluate methods to measure and control erosion and sedimentation rates.

Progress: The redistribution of fallout cesium-137 across the landscape can be used to measure soil erosion rates and soil redistribution patterns on watersheds. These findings are significant since this method measures the net movement of soil on a watershed while the USLE and other erosion models only predict the potential erosion. The cesium-137 technique is the only feasible means to measure actual sheet erosion and soil redistribution patterns at a landscape scale.

Plans: The ^{137}Cs technique will be used to study erosion and deposition patterns in the sustainable agricultural field studies at Beltsville. These studies will allow an assessment of current erosion/deposition patterns in the field and will allow us to quantify changes in future years.

Grass hedges planted at Beltsville in 1992, 1993, and 1994 in areas of ephemeral gullies will continue to be evaluated for their effectiveness in reducing soil loss and their effects of crop production. These studies are part of a joint SCS-ARS nationwide effort to evaluate grass hedges for erosion control.

Old CRIS Project 1270-13610-002-00D: Quantification and Integration of Basin Scale Hydrologic Fluxes
New CRIS Project 1270-13610-004-00D: Hydrologic and Climate Processes at Basin Scale

Objective: Integrate remote sensing measurements and GIS technologies into models. This will require the development of techniques for combining multifrequency remote sensing data which will provide important information for water and energy balance models. These include soil moisture estimates from microwave sensors, vegetation cover from visible and near-IR, surface temperature from thermal-IR, and vegetation height, density and local and regional roughness from laser altimeter data.

Progress: Airborne laser data have been used to measure vegetation height, cover, density, and distribution. This information has been used to estimate aerodynamic roughness and to infer vegetation type. These studies demonstrate that

airborne laser data can be used to measure vegetation properties and landscape patterns of large areas quickly and quantitatively. Laser altimeter technology is valuable for understanding vegetation patterns and characteristics, improving estimates of infiltration, evapotranspiration and aerodynamic roughness, and for making decisions for managing natural resources.

Plans: Research will continue on the use of airborne laser altimeter data to estimate aerodynamic roughness over large areas. These estimates will be combined with other landscape data to estimate parameters for local, regional and global modeling efforts of energy fluxes and evapotranspiration.

Old CRIS Project 1270-13660-003-00D: Remote Sensing in Hydrology
New CRIS Project 1270-13660-005-00D: Remote Sensing for Hydrology

Objective: Investigate the application of airborne altimetry for measuring and monitoring surface properties and patterns of the landscape. Investigate the application of remotely sensed spectral data for monitoring surface water quality in agricultural lakes and reservoirs.

Progress: An airborne laser altimeter has been used to measure erosional features of the landscape. Laser measurements of macroscale or microscale topography can be used to measure topography, channel and gully degradation and aggradation and to study their relationship to the surrounding landscape. Such measurements allow better characterization of flow and stability characteristics necessary for engineering studies and construction. Large area measurements provide valuable data for managing and understanding channel and gully erosion.

Studies have established that satellite spectral data can be used to monitor suspended sediment in surface water. Using this technique large segments of the landscape can be monitored quickly to determine the location of the most seriously sediment polluted water bodies. Conservation efforts can then be targeted to those watershed with the most serious erosion problems, thus providing a useful management tool for conservation agencies.

Plans: Studies will continue on the use of an airborne laser altimeter to measure surface properties of the landscape such as topography, landscape roughness and vegetation height and cover. Algorithms for data processing will be developed based on field and laboratory experiments and measurements.

Techniques will be developed to monitor surface water quality in lakes and reservoirs. Data collected using ground, aircraft, and satellite data along with hyperspectral data from ground and aircraft platforms will be used to develop techniques to monitor suspended sediments and chlorophyll in lakes and reservoirs.

III. Cooperators:

ARS:

Mr. J.H. Everitt, Remote Sensing Research, Weslaco, TX
Mr. D.E. Escobar, Remote Sensing Research, Weslaco, TX
Dr. J.D. Garbrecht, Nat'l Ag. Water Quality Lab, Durant, OK
Dr. E.H. Grissinger, National Sedimentation Lab, Oxford, MS
Dr. K.M. Havstad, Jornada Experimental Range, Las Cruces, NM
Mr. J.B. Murphey, National Sedimentation Lab, Oxford, MS
Dr. M.S. Seyfried, NW Watershed Research Center, Boise, ID
Dr. M.A. Weltz, SW Watershed Research Center, Tucson, AZ
Dr. C.M. Cooper, National Sedimentation Lab, Oxford, MS
Dr. S.C. McIntyre, Nat'l Ag. Water Quality Lab, Durant, OK
Dr. F.R. Schiebe, Nat'l Ag. Water Quality Lab, Durant, OK
Dr. W.D. Kemper, NPS, Beltsville, MD

Other:

Dr. C. Blazques, University of Florida, Coca Beach, FL
Dr. D.R. Breininger, NASA Bionetics Corp., KSC, FL
Dr. D.L. Evans, U.S. Forest Service, Starkville, MS
Mr. H.D. Fox, SCS, Tucson, AZ
Dr. C.R. Hinkle, NASA Bionetics Corp., KSC, FL
Dr. D.M. Jacobs, U.S. Forest Service, Starkville, MS
Dr. M. Menenti, Wageningen, The Netherlands
Dr. J.A. Harrington, Kansas State University, Manhattan, KS
Dr. T.A. Iivari, SCS NE Technical Center, Chester, PA
Mr. J. Englert, SCS Plant Material Center, Beltsville, MD
Ms. G. Meyers, SCS Plant Material Center, Beltsville, MD

IV. Curriculum Vitae:

Education:

1960 B.A. Biology, Pfeiffer College, Misenheimer, NC
1962 M.S. Botany, University of Tennessee, Knoxville, TN
1967 Ph.D Botany, University of Georgia, Athens, GA

Professional Employment:

1959-1960 Laboratory Assistant, Department of Natural Sciences, Pfeiffer College, Misenheimer, NC
1960-1962 Graduate Research Assistant, U.S. AEC, Mineral Cycling Project, University of Tennessee, Knoxville, TN
1962 Research Associate, Environmental Sciences Division, Oak Ridge National Lab., Oak Ridge, TN
1962-1964 Biological Research Specialist, Medical Research Laboratory, U.S. Army Biological Research Division, Edgewood Arsenal, MD

1964-1966 Graduate Research Assistant, NIH Public Health Service Radioactive Fallout Project, University of Georgia, GA
1966-1967 Graduate Research Fellow, University of Georgia, Athens,GA
1967-1968 Post-Doctoral Fellow in Plant and Soil Sciences, USDA-ARS, Southeast Watershed Research Center and the University of Georgia, ARS Hydrologic Study Team
1968-1973 Botanist, Sedimentation Laboratory, USDA-ARS, Oxford, MS
1973-1979 Soil Scientist, Sedimentation Lab., USDA-ARS, Oxford, MS (Special assignment to National Program Staff 1/78 to 8/79)
1979-1983 Staff Scientist, National Program Staff, USDA-ARS, Beltsville, MD
4/83- Soil Scientist, Hydrology Laboratory, USDA-ARS, Beltsville, MD
9/93- Acting Research Leader, Systems Research Laboratory, USDA-ARS, Beltsville, MD

<u>Membership in Professional Societies</u>:

American Geophysical Union (AGU)
American Society of Agronomy (ASA)
American Society of Photogrammetry and Remote Sensing (ASPRS)
Association of Southeastern Biologists (ASB)
Ecological Society of America (ESA)
International Association for Hydrological Sciences (IAHS)
Soil Conservation Society of America (SCSA)
Soil Science Society of America (SSSA)

<u>Offices and Committee Assignment Held In Professional Societies:</u>

Member of the Nominating Committee, University of Mississippi Chapter of Sigma Xi, 1974-1977
Associate Editor, Journal of Environmental Quality, 1978-1986
Soil Conservation Society of America (SCSA) liaison with the National Industry State Agriculture Research Committee (NISARC), 1983-1991
Association of Southeastern Biologists (ASB) liaison to American Association for the Advancement of Science (AAAS), Biological Sciences Section, 1987 - 1993
Ecological Society of America representative on the Board of Directors of the Renewable Natural Resources Foundation (RNRF), 1988 - present
Soil Conservation Society of America (SCSA) liaison with the Agriculture Research Institute (ARI), 1988-1991.
Soil Science Society of America (SSSA) liaison to American Association for the Advancement of Science (AAAS) Biological Sciences Section, 1988 - 1993
President-elect, President, Past-President of the Metropolitan Washington Chapter of the Ecological Society of America, 1989 - 1992

Elected to the Executive Committee of the Board of Directors of RNRF, 1990 - 1991, reelected for 1992-1995
Elected Secretary of the International Committee on Remote Sensing and Data Transmission of the International Association of Hydrological Sciences, 1992-1996
Member of the Ecological Society of America's Committee on Oversight and Society Interactions, 1993-

<u>Awards:</u>

Natural Sciences Award at Pfeiffer College, 1959
USDA Certificate of Merit/Outstanding Performance Award, 1981
USDA Certificate of Merit for Research, 1989
Outstanding paper award for 1989 from the Transactions of ASAE for paper entitled, "Airborne Laser Measurement of the Topography of Concentrated Flow Gullies," Transactions of the America Society of Agricultural Engineers 32:645-648, 1989
USDA Certificate of Appreciation for Earth Day Activities, 1990
USDA Certificate of Merit/Outstanding Performance Award, 1990 1991 1992 1993
ARS Agriculture and the Environment Award for outstanding career research on the environment, 1992

<u>Refereed Publications Since 1991</u>:

Cooper, C.M., F.R. Schiebe and J.C. Ritchie. An inexpensive sampler for obtaining bulk sediment cores. Environmental Geology and Water Sciences 18(2):115-117. 1991.

Ritchie, J.C. and C.M. Cooper. An algorithm for using Landsat MSS for estimating surface suspended sediments. Water Resources Bulletin 27(3):373-379. 1991.

Ritchie, J.C., J.H. Everitt, D.E. Escobar, T.J. Jackson and M.R. Davis. Airborne laser measurements of rangeland canopy cover. J. Range Management 45:189-193. 1992.

Jackson, T.J., T.J. Schmugge, R. Parry, W.P. Kustas, J.C. Ritchie, A.M. Shutko, A. Haldin, E. Reutov, E. Novichikhin, B. Liberman, J.C. Shiue, M.R. Davis, D.C. Goodrich, S.B. Amer and L.B. Bach. Multifrequency passive microwave observations of soil moisture in an arid rangeland environment. International Journal of Remote Sensing 13(3):573-580. 1992.

Ritchie, J.C., T.J. Jackson, J.H. Everitt, D.E. Escobar, J.B. Murphey and E.H. Grissinger. Using an airborne laser to study landscape features. J. Soil and Water Conservation 47:104-107. 1992.

Schiebe, F.R., J.A. Harrington, Jr. and J.C. Ritchie. Remote sensing of suspended sediments: The Lake Chicot project. International Journal of Remote Sensing 13:1487-1509. 1992.

Ritchie, J.C., J.B. Murphey, E.H. Grissinger and J.D. Garbrecht. Monitoring streambank and gully erosion by airborne laser, pp. 161-166. In: R.H. Hadley and T. Mizuyama (eds.), Sediment Problems: Strategies for Monitoring, prediction, and Control, International Association Hydrological Sciences Publ. #217, 1993.

Ritchie, J.C., D.L. Evans, D.M. Jacobs, J.H. Everitt and M.A. Weltz. Measuring canopy structure with an airborne laser altimeter. Transactions of the America Society of Agricultural Engineers 36:1235-1238. 1993.

Ritchie, J.C., T.J. Jackson, E.H. Grissinger, J.B. Murphey, J.D. Garbrecth, J.H. Everitt, D.E. Escobar, M.R. Davis and M.R. Weltz. Airborne altimeter measurements of landscape properties. Hydrological Sciences J. 38 (5):403-416. 1993.

Weltz, M.A., J.C. Ritchie and H.D. Fox. Comparison of laser and field measurements of vegetation heights and canopy cover. Water Resources Research 30:1311-1319. 1994.

Menenti, M. and J.C. Ritchie. Estimation of effective aerodynamic roughness of Walnut Gulch watershed with laser altimeter measurements. Water Resources Research 30:1329-1337. 1994.

Ritchie, J.C., E.H. Grissinger, J.B. Murphey and J.D. Garbrecth. Measuring channel and gully cross-sections with an airborne laser altimeter. Hydrological Processes J. 7:237-244. 1994.

I. RALPH T. ROBERTS, Computer Program Analyst

II. CRIS projects:

Old CRIS Project 1270-13610-002-00D: Quantification & Integration of Basin Scale Hydrologic Fluxes
New CRIS Project 1270-13610-004-00D: Hydrologic and Climate Processes at Basin Scale

Objective: To develop methods for parameterizing existing hydrologic models to encompass changes in scale. To investigate the use of remotely sensed data (which is spatial in nature) as the basis for scaling up from point or small scale processes to basin scale. Develop methods for understanding how hydrologic processes are affected by climate change on local, regional and global scales. Develop methods to evaluate effects of climate change on snowmelt, streamflow and groundwater recharge using hydrologic models.

Progress: Provided continuing support for the Snowmelt Runoff Model (SRM). The most recent general release of SRM, Version 3.2, contains several minor enhancements to the model's "climate change" algorithms. In 1994, an updated user's manual for this version of the model was completed and published by the University of Bern Department of Geography. In 1993 and 1994, several additions were made to the "research" version of SRM that expand the scope of the model's climate change processing algorithm. The original algorithm isolated climate change on only the designated snowmelt period, ignoring the effect that a changed climate during the "lead-up" period before the snowmelt season would have on many of a basin's variables and parameters, in particular, its conventional snow depletion curves. With these recent modifications, SRM can better perform more realistic year-round climate-change simulations.

Plans: Continue work on the "research" version of SRM. In the near term, this will include development of additional "year-round" data sets for several basins to facilitate testing of the new climate change algorithm. A complete rewrite of the program code is planned during the next two years, to consolidate and reorganize the many changes and enhancements made to SRM since it was originally ported to the microcomputer in 1986, and to take advantage of capabilities and features available in the Microsoft Windows environment.

Old CRIS Project 1270-13000-005-00D: Hydrologic Processes Related To Water Quantity and Quality
New CRIS Project 1270-13000-006-00D: Environmental Hydrology

Objective: Develop improved snowmelt runoff forecast procedures, determine the effects of agricultural management systems on infiltration and chemical transport. Develop and test procedures for incorporating the effects of preferential flow on infiltration and groundwater quality. Evaluate factors affecting offsite downstream water quality and sedimentation in lakes and reservoirs using cesium-137 to measure erosion rates and sediment and carbon deposition in lakes. Update hydrologic modules of WEPP.

Progress: Served as the programming point of contact for users of the Snowmelt Runoff Model, Version 3.2, and two programs distributed by the Soil Conservation Service, Technical Release 55, Urban Hydrology for Small Watersheds (TR55) and the Engineering Field Manual, Chapter 2. Resolved several requests for assistance by users of the microcomputer software that implements TR55 and EFM2. Worked with a user of SRM in Switzerland to correct a minor discrepancy in how the model distributed runoff at points where basin lag time changed.

Plans: Continue to be responsive to requests for programming/processing support by Hydrology Lab personnel, and where appropriate, other ARS and non-agency requestors. Possibility exists for a cooperative effort with Goeff Kite of the Canadian National Hydrology Research Center, to integrate portions of his model, SLURP Semi-distributed Watershed Model, with SRM.

Old CRIS Project 1270-13660-004-00D: Storage and Distribution of ARS Water Data
New CRIS Project 1270-13000-006-00D: Environmental Hydrology

Objective: Maximize the benefits of water data collected by various ARS Watershed Research Centers located in the United States by making the data available to research scientists, engineers, and educational organizations.

Progress: Developed DOS-based prototype software for accessing ARS water data contained in the Water Data Center (WDC) CD-ROM database. This software uses state-of-the-art Graphical User Interface (GUI) concepts to interface with a user. Based on the concepts demonstrated in the prototype, we are developing a Microsoft Windows-based version of the program. The basic code is complete and is undergoing testing and debugging. This program interacts with the user in a fashion consistent with most other Windows software. Features in this software include the

ability to quickly display data from any of 16000+ station years of data contained on the CD-ROM, both graphically and in tabular fashion.

In addition to the standard query dialogue that allows a user to select subsets of the full data base by location, station, and/or station year, the program also includes dialogues that poll the data base by watershed size or period of record. Any data selected during the query process can be saved to local files or copied to the Windows clipboard, for later access by other programs.

Plans: Development of the Windows version of the WDC CD-ROM access software will continue. The CD-ROM and access software should be ready for general release by the end of 1994. Significant work remains in compiling a complete set of digitized maps for inclusion on the CD-ROM. Once the first version of the software and CD-ROM are released, efforts will be directed at expanding the capability of the software and the content of the database.

III. Cooperators:

Other:

Jaroslav Martinec, Consulting Hydrologist, Davos, Switzerland
Klaus Seidel, Institute for Communications, Zurich, Switzerland
Don Woodward, USDA-SCS, Washington, DC

IV. Curriculum Vitae:

Education:

1975 B.S. Business Administration, University of Maryland

Professional Employment:

1973-1976 Computer Programmer, Naval Intelligence Processing Systems Support Activity, Alexandria, VA
1976-1978 Computer Systems Analyst, Overseas Private Investment Corporation, Washington, D.C
1978-1984 Computer Specialist, Water Data Laboratory, USDA, ARS, Beltsville, MD
1985- Computer Programmer/Analyst, Hydrology Laboratory, USDA, ARS, Beltsville, MD

Memberships in Professional Societies:

Intergovernmental Council on the Technology of Information Processing
Interagency Advisory Committee on Water Data, Subcommittee on Water Data Information and Exchange
Capital Area SysOps Association

Awards:

USDA Certificate of Merit/Superior Performance Award 1979 1983 1985 1991
Western Snow Conference Best Paper Award 1987

Publications Since 1991:

Martinec, J., Rango, A., and Roberts, R.T. Rainfall-Snowmelt Peaks in a Warmer Climate. Symposium Proceedings, AWRA 28th Annual Conference, Reno, NV. 1992.

Martinec, J., Rango, A., and Roberts, R.T. User's Manual for the Snowmelt Runoff Model (SRM) (Updated Edition 1992, Version 3.2). Hydrology Laboratory Technical Report HL-17. 1992.

Roberts, R.T., and Thurman, J.L. A Graphical User Interface for ARS Water Data on CD-ROM. Symposium Proceedings, Federal Interagency Workshop of Hydrologic Modeling Demands for the 90's, Fort Collins, CO. 1993.

Thurman, J.L. and Roberts, R.T. Use of an On-Line Information System and CD-ROMs for Dissemination of ARS Water Data. Symposium Proceedings, Federal Interagency Workshop of Hydrologic Modeling Demands for the 90's, Fort Collins, CO. 1993.

Martinec, J., Rango, A., and Roberts, R.T. Snowmelt Runoff Model (SRM) User's Manual (Updated Edition 1994, Version 3.2). Geographica Bernensia, Department of Geography - University of Bern, 1994.

Martinec, J., Rango, A., and Roberts, R. Modelling the Redistribution of Runoff Caused by Global Warming. AWRA Summer Symposium, Jackson Hole, WY. 1994.

I. Thomas Schmugge, Physical Scientist

II. CRIS Projects:

Old CRIS Project 1270-13610-002-00D: Quantification and Integration of Basin Scale Hydrologic Fluxes
New CRIS Project 1270-13610-004-00D: Hydrologic and Climate Processes at Basin Scale

Objective: Investigate techniques for quantifying basin scale fluxes by developing models that utilize remote sensing data with atmospheric inputs at local (i.e., weather station data) and regional (i.e., atmospheric boundary layer data) scales. Evaluation of the fluxes and state variables such as surface temperature and soil moisture computed by processed-based models will be made with data collected from large scale multidisciplinary field experiments.

Progress: The purpose is to develop techniques for the utilization of remotely sensed surface temperatures in the thermal infrared for agricultural purposes. As a team member for the TIR instrument on EOS (ASTER) I have the responsibility for developing a method for using surface temperature data to estimate evapotranspiration. Working with W. Brutsaert of Cornell University we have shown that temperatures from the avhrr sensor can be used to estimate the fluxes over a forest in the HAPEX-MOBILHY experiment. Using data from the Thermal Infrared Multispectral Scanner (TIMS) we have studied the spectral variations of agricultural surfaces in the 8 - 12 micron region. The results show that for fully vegetated surfaces there is no spectral variation but that there can be significant variation for soils. This has been shown in results from both the HAPEX-MOBILHY, southwest France in 1986. and HAPEX-Sahel, Niger west Africa 1982, experiments.

Plans: Extend the Brutsaert method form the forested conditions of HAPEX-MOBILHY to the rolling grassland conditions of central Kansas, Konza prairie in FIFE. Use the data from both HAPEX's to study the relation between surface temperature and the ndvi vegetation index.

Old CRIS Project 1270-13660-003-00D: Remote Sensing in Hydrology
New CRIS Project 1270-13660-005-00D: Remote Sensing for Hydrology

Objective: Develop techniques for combining multifrequency remote sensing data which will provide important information for water and energy balance models. These include soil moisture estimates from microwave sensors, vegetation cover from visible and near-IR, surface temperature from thermal-IR, and vegetation

height, density and local and regional roughness from laser-altimeter data. All this information will be integrated into energy balance and hydrologic models for computing spatial distributed fluxes and permit the integration of the fluxes to larger scales.

Progress: In our study on the use of passive microwave techniques for mapping soil moisture, the PushBroom Microwave Radiometer (PBMR) measuring the thermal emission from the ground at a wavelength of 21-cm was used in several field experiments to successfully map surface soil moisture. In the Monsoon 90 and HAPEX-Sahel experiments there were several flights which covered a wide range of moisture conditions. The sensitivity of the microwave brightness temperature to surface soil moisture was about as expected from previous experiments and theory. The relative change in surface soil moisture from one day to the next was used to estimate the surface vapor flux in Monsoon 90 and to detect soil hydraulic heterogeneities in the HAPEX-Sahel experiment.

Plans: We plan to use these microwave data with observations of surface temperature to further quantify our estimates of the surface fluxes. Preliminary analysis of the combined PBMR and PORTOS, a multiwavelength French radiometer, indicates that the shorter wavelength data from PORTOS can be used to estimate the biomass of the surface vegetation cover. This can then be used to correct for vegetation effects in the extraction of soil moisture information with the PBMR.

III. Cooperators:

<u>ARS</u>:

Dave Goodrich, USDA-ARS Southwest Watershed Research Center, Tucson, AZ

<u>Other</u>:

Ann Kahle, Dr. Simon Hook and Frank Palluconi of the Jet Propulsion Laboratory
Bernard Seguin, INRA Station de Bioclimatologie
Andre Chanzy, INRA Soil Science
W. Brutsaert of Cornell Univ
Ann Hsu of NASA/GSFC
Vicente Caselles and Cesar Coll
Bhaskar Choudhury and James Wang, NASA/GSFC Hydrological Sciences Branch on the Karl Hollenbeck and Dr. George Hornberger, Department of Environmental Studies, University of Virginia
Toby Carlson, Department of Meteorology, Pennsylvania State University
Yann Kerr, LERTS/CNES Toulouse, France

Massimo Menenti and Peter van Oevelen, Agricultural University, Wageningen, The Netherlands
Paolo Pampaloni, IROE Florence, Italy

IV. Curriculum Vitae:

Education:

1959 B.S. Physics, Illinois Institute of Technology, Chicago, IL
1964 PhD. Physics, University of California, Berkeley, CA

Professional Employment:

1965-1970 Assistant Professor of Physics, Trinity College, Hartford, CN
1970-1971 NAS-NRC Senior Postdoctoral Fellow, NASA Goddard Space Flight Center
1971-1983 Physicist, Hydrological Sciences Branch, NASA/GSFC
1979-1983 Associate Editor, Journal of Geophysical Research
1984-1984 Acting Head, Hydrological Sciences Branch, NASA/GSFC
1984-1985 Senior Scientist, Hydrological Sciences Branch, NASA/GSFC
1986- Research Physical Scientist, USDA Hydrology Laboratory
1994 Visiting Research Scientist INRA Station de Bioclimatologie, Avignon, France

Membership in Professional Societies:

American Association for the Advance of Science
American Geophysical Union, Member of the Remote Sensing in Hydrology Committee
Institute of Electrical and Electronics Engineers, Member of Geoscience and Remote Sensing Society European Geophysical Society

Awards:

NASA Quality Increase Award, 1977 and 1981
GSFC Exceptional Performance Award, 1980
Best Paper for 1980 Award from IEEE Geoscience and Remote Sensing Society
GSFC Special Achievement Award, May 1985
USDA Certificate of Merit/Superior Performance Award, 1992 1993
USDA Research Fellowship, 1994
INRA Research Fellowship, 1994

Refereed Publications Since 1991:

Schmugge, T. J., F. Becker, and Z. L. Li. Spectral emissivity variations in airborne surface temperature measurements. Remote Sensing of Environment, 35:95-104. 1991.

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I. Jane L. Thurman, Computer Systems Analyst

II. CRIS Projects:

Old CRIS Project 1270-13660-004-00D: Storage and Distribution of ARS Water Data
New CRIS Project 1270-13000-006-00D: Environmental Hydrology

Objective: Maximize the benefits of water data collected by various ARS Watershed Research Centers located in the United States by making the data available to research scientists, engineers and educational organizations.

Progress: The ARS Water Data Base consists of rainfall and runoff data from over 300 watersheds. Since 1991 over 2,600 station years of data have been added to the data base creating a total of over 16,000 station years of data. About 200 years of daily air temperature have also been added. Temperature data are vital to many models greatly enhancing the usefulness of the data base to modelers. Additional retrieval capabilities have been developed to make the data easier to access by researchers. These capabilities include a CD-ROM and Internet access via anonymous ftp. A significant proportion of the data distributions have been made via the Internet since it has been available making this an extremely cost-effective distribution method. The development and organization of the Monsoon '90 data base, making the Monsoon '90 data base available through asynchrounous communications and providing Internet access have also added to the resources of the scientific community.

Plans: Ongoing activities include the development of computer files to generate maps of the watersheds. This will include scanned bit-image maps and digitized data. Another effort includes the capture of land use and watershed conditions into computer files which can be distributed with the hydrologic data. These efforts will increase the usefulness of the data by providing parameters needed for climate change studies, modeling and resource management studies.

The Water Data Center will continue to expand the user-friendliness of the data base, to add data to the system and to provide a safe environment for data which might otherwise be lost.

III. Cooperators:

<u>ARS:</u>

J. Steiner, Watkinsville, GA
A. Thomas, Tifton, GA
C. Hansen, Boise, ID
C. Richardson, Temple, TX

A. Hjelmfelt, Columbia, MO
L. Lane, Tucson, AZ
J. Bonta, Coshocton, OH
G. Foster, Oxford, MS
H. Pionke, University Park, PA
F. Schiebe, Durant, OK

Others:

R. H. Hawkins, Professor and Program Leader of Watershed Resources, University of Arizona, Tucson, AZ

IV. Curriculum Vitae:

Education:

1970 B.A. Mathematics and Computer Science, University of Nebraska

Professional Employment:

1970-73 Programmer, Programmer/Analyst, University of Nebraska, Lincoln, NE
1973-75 Programmer/Analyst, Newport News Shipbuilding and Drydock Co., Newport News, VA
1975-76 Programmer/Analyst, U.S. Department of Army, Ft. Monroe, Hampton, VA
1976- Computer Specialist, Computer Systems Analyst, Hydrology Lab, Beltsville, MD

Offices and Committee Assignments Held in Professional and Honorary Societies:

ARS alternate representative, Inter-Agency Committee on Water Data (IACWD)

ARS representative, Sub-committee on Spatial Water Data, joint sub-committee of the Federal Geophysical Data Committee and IACWD

Awards:

USDA Certificate of Merit/Superior Performance Award, 1979 1984

Publications Since 1991:

Rango, A., J. L. Thurman, W. H. Blackburn, F. R. Schiebe, and D. A. Woolhiser. Compilation and availability of Agricultural Research Service hydrological data for use in climate change studies. IN PRESS, NATO ASI series. 1991.

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